LYMPHATICS

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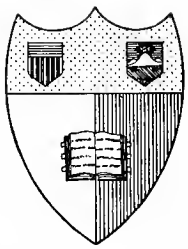


of the affection at birth or in early life, by the groups of thick-walled vesicles, often accompanied by telangiectasis and warty surface changes, by the discharge of lymph, when they are incised, and by the slow course. On superficial inspection the affection may resemble most a group of warts.

Prognosis.—The lesions usually increase slowly until they have attained a certain degree of development, when they remain nearly stationary. In one recorded case there has been spontaneous involution. After operative interference, as in all forms of lymphangiomata, the lesions are very likely to reappear.

Treatment.—Excision and caustics have been tried, but recurrence after the operation is not uncommon. Electrolysis has been thought by some to offer the most hope of success, but in this case also recurrences have been recorded. Each vesicle is to be transfixed by a needle attached to the negative pole of a galvanic battery, eight or ten cells being employed. The poor results of treatment probably are due to the presence of deep-seated anastomoses. *John T. Bowen.*

LYMPHANGIOSARCOMA. See *Sarcoma.*

LYMPHANGITIS.—All the tissue elements may be regarded as being bathed in lymph, which appears first in innumerable, minute, irregular gaps in the tissues, which gaps communicate in various ways with each other, and with minute lymphatic vessels, which latter, when traced onward from their beginnings, presently assume a structure comparable to that of narrow veins with very delicate walls and extremely numerous valves. These valves open away from the gaps of the tissues, as the valves of the veins open away from the capillaries. The lymphatic vessels emerging from the network of gaps unite to form somewhat larger ones, which pass either to a neighboring lymphatic gland or to join some larger lymphatic trunk. The lymphatics are arranged into a superficial and a deep set. The superficial lymphatics on the surface of the body are placed immediately beneath the integument, accompanying the superficial veins; they join the deep lymphatics in certain situations by perforating the deep fascia. The deep lymphatics, fewer in number and larger than the superficial, accompany the deep blood-vessels. Finally, the entire system ends in numerous vessels which open into two main trunks of very unequal importance—the thoracic duct and the right lymphatic duct. Lymphatics are found in nearly every texture and every organ of the body which contains blood-vessels. Interposed at numerous points in the course of the lymphatic vessels are the lymphatic nodes, which are small, solid, glandular bodies through which the lymphatic vessels pass. Lymph is the exudate of some of the liquid constituents of the blood as it circulates through the capillary blood-vessels into the tissue gaps or spaces, and carries nutriment to the tissues. It then receives from the tissues the products of their activity, and is collected from the lymph spaces into the lymph channels, whence it is carried to the lymph nodes, which act as filters for the lymph, besides adding to the lymph the lymphocytes, which act as scavengers (phagocytes) in the lymph and blood.

Reticular lymphangitis is applied to inflammation of circumscribed areas of lymphatic radicles, tubular lymphangitis to that of the larger continuous lymphatic trunks. Both forms often coexist. Either may be acute or chronic. Since we now know that all inflammation of lymph vessels is of microbic origin, we may drop the terms "idiopathic" and "traumatic" as being no longer descriptive. The lymphatics are so widely distributed that they must be severed or torn in every cut or bruise to a greater or less extent; but, as a rule, they collapse at once and give no trouble. From their open mouths, during the first hours following the receipt of a wound, comes much of the serous flow, to dispose of which drainage is necessary. This outward flow of the lymph, together with its coagulation and the collapse of the lymph vessels themselves, prevents the absorption into the organism, in most instances, of septic material. While lymphangitis is, generally speaking, the consequence of a wound, yet this is not an invariable rule, since infection has been known to penetrate through the unbroken skin of the hand, as seen in sepsis following immersion of the unwounded hands in the fluids of a cadaver at an autopsy, and also through mucous membranes in which there is no abrasion or scratch to be found, especially in the case of the throat, uterus, etc. The absorption of infective material is undoubtedly greatly facilitated by friction, pressure, the removal of the outer corneous layer, or the confining of a discharge under tension. Recent wounds are much more likely to be attacked than granulating ones, because granulations themselves, so long as they are uninjured, do not absorb, the current setting in the opposite direction toward the surface. Whatever the irritant may be, it probably does not cause inflammation of the wall of the vessel unless it is arrested; if this does not take place, it is hurried on to the neighboring lymphatic glands, and sets up inflammation there. Illustration of this is seen in cases in which surgeons have received the tiniest needle prick, so slight as to leave no mark, in which the first intimation of sepsis is found in inflamed lymph nodes in the neighborhood. The heat of the sun and the Roentgen rays produce an inflammation of the skin in which the lymphatics share to a certain extent. Lymphangitis is incidental to the course of specific diseases, such as scarlet fever, measles, diphtheria, tuberculosis, syphilis, and gonorrhœa; in these, however, the inflammation of the lymphatic nodes is the more prominent feature. A typical lymphangitis is seen in erysipelas (which see). It may also result from the bites of insects and venomous reptiles. It is a constant lesion in bubonic plague.

Pathology.—The changes are best seen in the larger trunks. Their endothelial cells swell, lose their distinctness of outline, and to a variable extent become detached. The walls of the lymph vessels and the delicate surrounding cellular tissue become more or less densely infiltrated with pus cells, fibrin, and serum. The lumen of the vessel, the interstices in its walls, and the cellular sheath are filled with a coagulating exudation. The stream of lymph through the vessel ceases because of the thrombus. The blood-vessels surrounding the inflamed area dilate, and the blood circulates more rapidly and in greater quantity. The future course, whether it is to be either resolution, organization, or suppuration, depends upon the cause. If the irritant be slight and transient, resolution may begin at once. The thrombus liquefies within the lumen, and the exudate within and without the walls is absorbed. The endothelium is regenerated and the circulation is re-established. Organization is likely to occur if the irritant action is chronic and persistent, as in syphilis. The lumen becomes occluded through transformation of the thrombus into connective tissue, and the coats of the vessels and the cellular tissues in which they lie become hard, dense, and sclerosed, likewise from organization of the exudate into connective tissue, and some degree of permanent thickening results in the tissues. Suppuration takes place when virulent micro-organisms are the exciting cause, producing coagulation-necrosis of the thrombus and exudate, and death of the vessel wall and surrounding tissues, resulting in cellulitis, or abscess, which may be circumscribed, or diffuse and spreading. The related neighboring lymph nodes are usually implicated also. The results of the extension of infection along the lymphatic channels are seen in some cases of suppurative appendicitis, where we may find inflamed mesenteric glands, isolated abscesses about the liver, empyema, etc.

Symptoms.—In the reticular form the inflammation shows itself in red, tender, œdematous, swollen patches, which may succeed each other up the limb, one fading as a neighboring area blooms out. The inflammation extends from the periphery. Pain is always present and varies, like the other symptoms, with the severity and extent of the process; it is increased by movement, and is accompanied by a feeling of tension in the part. Ordinary erysipelas presents a typical form of reticular

lymphangitis in which the inflammation is produced by the invasion of the lymphatic channels by the streptococcus of erysipelas. If the inflammation is extensive there may be a considerable lymphatic œdema and the circumference of a limb may be much increased. Some cellulitis accompanies all lymphangitis, and some lymphangitis, on the other hand, attends all cellulitis. Which element preponderates is very often a matter of uncertainty, but the question is not an important one, because both require the same treatment.

The tubular variety shows itself most plainly when the superficial vessels are involved. These latter appear in the skin as wavy red lines travelling toward the neighboring lymphatic glands. They are very tender to the touch, slightly raised from the surface, with a cord-like beaded feel, due to the infiltration and plastic thrombosis in and around them. Sometimes they are quite narrow; sometimes, when the poison is very active, an inch or more in breadth, from extension of the inflammation to the surrounding cellular tissues. At the same time the glands are swollen and tender, and, if the affection is extensive, the limb below may be œdematous. Here and there the red lines disappear, where the superficial lymphatics empty themselves into the deeper set, or swell out and become broader opposite plexuses and valves. In cases of virulent infection the inflammation may result in the formation of small abscesses at intervals along the course of the vessels before the glands are reached.

When the deeper vessels are affected, the diagnosis may not be easy if no superficial inflammation be present. Usually, however, faintly outlined patches of redness are visible here and there upon the skin, where the superficial plexuses communicate with the deep ones. In any case deep pressure along the course of the affected vessels is painful, but otherwise most of the usual signs are wanting. Diagnosis between it and ordinary cellulitis is difficult. In both varieties the glands are apt to be swollen and tender.

The constitutional symptoms will vary according to the extent of the local inflammation, the severity of the cause, and the general health and resisting power of the patient. Simple lymphangitis is accompanied by a varying degree of fever, with the usual results thereof—malaise, thirst, headache, anorexia, etc. When suppuration sets in, the general symptoms become much aggravated, pain is severe and prostration extreme, and high fever with possibly chills and sweating makes itself evident. In severe cases septicæmia may develop.

Prognosis.—Simple lymphangitis is rarely serious and runs its course in from a few days to several weeks; the general health and robustness of the patient have a marked influence, recovery being slow in the subjects of alcoholism, chronic gout, diabetes, and renal disease, and in those debilitated by poor living and overwork. When suppuration supervenes (leading to a cellulitis) or when some virulent septic poison is the cause of the trouble, the illness may assume a grave character, viz., that of septicæmia. If the vessels which run in groups are extensively destroyed, a condition of solid œdema is likely to persist which may leave the limb more or less crippled.

Diagnosis.—Phlebitis is closely related to lymphangitis in its symptoms, but a thrombosed vein forms a deeper-seated, coarser cord than does a similarly affected lymph vessel, the cutaneous redness is not so vivid, the pain is less acute, the general fever is not so intense, and the tendency to glandular involvement is much less. Inflammation of the deep lymphatics may at times be differentiated from ordinary cellulitis by an earlier involvement (in the case of the former of these two inflammations) of the neighboring lymphatic glands, by the presence of lymphatic œdema, and by the appearance of patches of superficial reticular lymphangitis at points of anastomosis with deeper trunks.

Treatment.—The first indication is to remove the cause, if that can be detected. All possible sources of infection should be sought for and appropriately treated. Pustules and abscesses should be opened and drained, unhealthy wounds are to be cleaned thoroughly and opened further if drainage is not sufficiently free. These avenues of infection should be encased in compresses which are kept wet with some antiseptic solution. The part should be put at rest, and the limb elevated to diminish the amount of blood entering it, as well as to facilitate the return of the lymph. Tension within the area of lymphangitis, if very great, should be relieved by incision and drainage, without waiting for suppuration to take place. The whole affected area should be kept covered with compresses continually wet with some soothing, antiseptic solution, such as aluminum acetate, Thiersch's solution, creolin (one-half per cent.), bichloride (1 in 2,000), or a solution of lead and opium. These wet dressings should extend above and include the swollen lymphatic glands. Hot fomentations in some cases may be more grateful than the cooler solutions. As soon as pus forms or is suspected, the abscess should be freely incised, evacuated, and drained. In severe cases in which the process threatens to spread and is difficult to control, a very effectual means of combating this is found in the continuous immersion of the limb in an iced solution such as any one of those mentioned above.

Constitutional treatment consists in supporting and eliminating measures. The diet should be liberal and solid food should not be withheld unless a high degree of fever causes it to disagree. The bowels should be kept freely open. Quinine, and later iron in addition, are the most efficient medicines. Stimulants will be needed only in severe cases and should then be given in large doses (one to two ounces of whiskey every two hours). It seems remarkable (much discussion to the contrary notwithstanding) how favorably a free exhibition of alcohol in severe septic infections will affect the constitutional symptoms, as shown by a dry, brown tongue becoming cleaner and moister, by improvement in the appetite and in the cerebral symptoms, by strengthening and slowing of the heart, and by a diminution in the degree of the prostration. Persistent œdema and stiffness in muscles and tendons, after subsidence of the inflammation and healing of the wounds, are to be overcome by bandaging, hydrotherapy, electricity, and massage. It may be necessary to give analgesics and hypnotics, such as the bromides, codeine, and trional, during the acute stage. Opium should be used only as a last resort.

Chronic Lymphangitis.—This is seen in the course of certain diseases, such as elephantiasis (which see), bubonic plague, tuberculosis, syphilis, etc. Tuberculous lymphangitis occurs both in large and in small lymph vessels in whose walls miliary tubercles and diffuse tubercle tissue may grow, producing partial or complete obstruction. This may occur independently, but it is most frequently seen in connection with tuberculous inflammation of adjacent structures, particularly the lymph nodes. In the vicinity of tuberculous ulcers in the intestines, the subserous lymph vessels, which pass from the ulcers, are often distended with the products of tuberculous inflammation, which makes them look like dense white knobbed cords. Syphilitic inflammation of the lymph vessels not infrequently occurs in the vicinity of syphilitic ulcers in the primary stage. In later stages there may be thickening of the walls of the vessels and the development of gummy tumors in and about them.

Clarence Arthur McWilliams.

LYMPHATIC SYSTEM.—(Synonyms: Absorbent system; Latin, *Systema lymphaticum;* French, *Système lymphatique;* Italian, *Sistema linfatico;* German, *Lymphsystem oder Saugadersystem.*) The lymphatic or lymph vascular system consists of the vessels and spaces containing lymph or chyle (colorless or white blood), and of the lymphatic or conglobate glands situated in the course of the vessels, and through which the lymph must percolate in somewhat the same manner as water passes through a sponge. This system is an appendage of the blood-vascular system, its two terminal trunks, the thoracic duct and the right common lymphatic trunk, ending in the great veins at the base of the neck.

A tolerably correct pictorial idea of the entire vascular

system may be formed by considering the blood-vascular part as made up of a great tree, the heart forming a short trunk and the arteries, veins, and capillaries, the branches; but there is present the untree-like character of the direct union of the terminal twigs of the arteries and veins, that is, the venous and arterial capillaries are continuous. The lymphatic system may then be represented by two vines of unequal size, but which together follow all the blood-vessels to their ultimate ramifications, and in many places even send minute twigs beyond them. The analogy with a vine is further borne out by the lymphatic vessels, as they remain of a more uniform diameter than the blood-vessels; and, finally, the terminal twigs, like those of a real vine, end freely or blindly, often in slight expansions like leaves, thus forming a marked contrast with the terminal twigs of arteries and veins, which cannot be properly said to terminate at all. In a word, the blood-vascular system forms a complete circle or circuit in itself, while the lymph-vascular system joins the blood-vascular system at its central or trunk end, but ends blindly at the periphery.

Historical.—It is not to be wondered at that the lymphatic system should not have been discovered and investigated before the circulation of the blood and the general relations of the blood-vascular system had been investigated and understood; and yet, from the prominence of the lymphatic glands, they were seen by Hippocrates; but, having no notion of their true relations, he classed them with the other glandular structures of the body; so, too, there is strong reason for believing that the lacteals were seen in animals by the two famous Alexandrian physicians, Erasistratus and Herophilus; but their significance was not comprehended. About the middle of the sixteenth century (1564), Eustachius found the thoracic duct in the horse, and traced it, both to its beginning in the abdomen, where he became bewildered, and to its termination in the great veins in the neck. He did not profess to understand the significance of this vessel, but named it, from its color and position, *vena alba thoracis*.

It was not until 1622, when Asellius saw the lacteals in a dog, that the real significance of these vessels was appreciated. The whole scientific world was about this time aroused by the epoch-making discussions and discoveries of Harvey on the circulation of the blood, and everything like a vessel was scrutinized with inquiring eyes. The story of Asellius in connection with the discovery and comprehension of the significance of the lacteals will never lose its interest as long as the human mind is striving to comprehend the universe, either in its details or in the *ensemble*. Having opened the abdomen of a living dog, to show to some friends the arrangement of the nerves and the working of the diaphragm, Asellius saw in the mesentery some white cords in addition to the nerves and vessels with which he was familiar, and upon cutting one of them and seeing a white liquid exude, he immediately recognized that they were a new kind of vessel. Most fortunately for him and for science, the dog, killed on the following day to find out still more about these curious white veins, showed none of them. Fortunately, because it led Asellius to consider the conditions under which they appeared in the first dog, and wherein the conditions differed in the second. With the sure comprehension of a scientific mind, he saw that the only essential difference lay in the presence of partly digested food in the first case, and in the absence of food in the second. When this condition was realized in a third dog, the lacteal vessels reappeared, and the relation between the products of digestion and these vessels was fully established for the dog.

Not content with the experiments on the dog, Asellius examined many other animals, showing in every case that there was a constant relation between digestion and the presence of the white fluid in the lacteal vessels. Owing to the powerful influence of the prevailing opinion that all matter must first go to the liver to be assimilated, Asellius supposed that the newly found lacteals extended to the liver. It is difficult to comprehend how a mere hypothesis could blind the eyes of so skilled an anatomist, but so it was, and the belief that the lacteals passed to the liver continued to prevail for nearly twenty-five years.

About 1650, the great facts concerning the lymphatic system, as they are understood at the present day, were discovered by four men in different quarters of Europe. In France, Pecquet showed that the *venæ aquosæ hepatis*, or lymphatic vessels connected with the liver, were not the continuation of the lacteals to the liver, but were vessels extending either to the lacteals, or with them into a common reservoir into which both opened, and that the reservoir was continued as a somewhat smaller vessel (the thoracic duct) through the thorax, to terminate in the great veins in the neck. The same facts were observed by Rudbeck, in Sweden, at about the same time, and completely overthrew the notion that all absorbed food must first pass to the liver for assimilation before entering the blood; for here was *apparently* the only path of the absorbed food, and it terminated directly in the great veins on their way to the heart.

At about this date, Bartholin in Denmark, Jolive in England, and Rudbeck in Sweden, discovered the general lymphatics of the body. They also showed that these lymphatics (*vasa lymphatica* of Bartholin, *vasa aquosa* of Rudbeck), or serous vessels, either united with the lacteals in the *chylocyst* or joined the thoracic duct, and consequently the lymph and chyle or lacteal fluid unite, and together flow into the great veins. In other words, they showed that the lacteals form only a special part of a great system distributed throughout the entire body. It may be said, in passing, that when the facts concerning these new vessels were presented to Harvey, he did not welcome the newly acquired knowledge. Doubtless the weight of years had quenched the enthusiasm of investigation, and he may have been troubled lest these newly discovered vessels might in some way prove a stumbling-block to his simple and easily comprehended explanation of the blood-vascular system.

Not much was added to the knowledge of the lymphatic system for nearly one hundred years after the main facts were established, and naturally, in those early times, with both undeveloped methods and superstition as impediments, knowledge was only general and obtained principally by investigating the lower animals. And yet, in 1628, a criminal was properly fed before execution, and the lacteals demonstrated in the mesentery after death, thus showing conclusively that the absorbed food in man takes the same course as in animals.

Between 1760 and 1787 there was a renewed activity in investigating the lymphatic system. In England the Hunters, Hewson, and Cruikshank, not only investigated the human lymphatics, but pushed their investigations to all forms of vertebrates, and they were found abundantly in all forms. The Munros, in Scotland, were also very active. In Italy the great anatomist, Mascagni, was preparing his magnificent work on the human lymphatics, a work which remains a standard to the present day; and reduced copies of his splendid folio plates are still to be found in every extensive account of this system.

As in all departments of human activity, the crowning discoveries in the lymphatic system are due to the work of an almost untold number of men; and yet a few present the principal and salient features so unencumbered with useless, distracting, or foreign details that they are, for the majority of minds, the true discoverers. They make the special knowledge a part of the knowledge of the race. So in the above historical sketch many names have been omitted, and undue prominence may have been given to others; barring these defects, it is hoped that it represents fairly well the progress from vague and uncertain to certain knowledge of this system.

Since the work named above, something noteworthy has appeared almost every decade, but it has been usually toward the elucidation of special details of function, origin, distribution, or structure, rather than an investigation of the whole field. The work of Sappey [1] forms an

exception to this general statement. His investigations have extended over more than forty years, and with a rare skill and all the refinement of modern anatomy, he has not only done much on the general subject both in human and comparative anatomy, but some of the difficult points have been elucidated by him. His atlas is probably, without qualification, the most important monograph that has appeared since Mascagni's.[13]

General Structure in Man and Animals.—Considered as a whole, the lymphatic system consists of minute and larger spaces, of definitely walled capillaries and larger trunks. Lymphoid or adenoid tissue seems also to be an integral part, and in man and the higher forms this adenoid tissue is, in part, aggregated into special masses, the lymphatic glands or nodes, situated in the course of the vessels and forming a sort of sponge-work through which the lymph must percolate on its course to join the blood-vessels.

Like the blood-vessels, the lymphatics may be divided into groups according to their position, as *ectal*—subcutaneous, subserous, or superficial, and *ental*,—subaponeurotic, submucous, or deep, and also as *visceral*—those belonging to the heart, lungs, urinary and generative organs, and the alimentary canal. Part of these, *i.e.*, those from the small intestine, are called lacteals or chyle vessels. All of the larger vessels possess more numerous valves than do the veins.

In distribution, the lymphatics follow mostly the course of the blood-vessels, but this does not apply to the subcutaneous lymphatics, as will be seen by comparing Figs. 3267, 3268, and 3269, with figures showing subcutaneous veins. Furthermore, in many situations lymph vessels, or lymph canals and spaces, extend beyond the blood-vessels and more intimately envelop the tissue elements.

In general, however, it may be stated that the ectal or superficial lymphatic trunks follow the veins, and the deep or ental lymphatic trunks follow the arteries. This anatomical relation was shown in 1836 by Breschet for the adult, and in 1902 by Dr. Florence Sabine[10] for the embryo.

The lymphatic capillary network, although agreeing in general appearance with a blood capillary network, is composed of larger vessels and its mesh is coarser. With the larger vessels the anastomoses are more frequent, but differ in character from the anastomoses of blood-vessels inasmuch as the parallel vessels divide equally or unequally, and unite at a very acute angle, making a long, narrow-meshed network (Fig. 3268); and nowhere is found such great disparity in the size of the vessels as is found with the great arterial and venous trunks. Even the terminal lymphatic trunks are minute as compared with the veins into which they empty. The entire lymphatic system is supposed to have a capacity one-half as great as the arteries, and perhaps more, but no very close approximation can be made on account of the structural peculiarities of the lymphatics, and the immense number of valves. In man and the higher forms, all lymph traverses one or more lymphatic glands before joining the common lymphatic trunks. The exceptions to this rule which have been reported from time to time have not been verified.

In the higher mammals the general arrangement and distribution of the lymphatics is as in man. So far as has been investigated, however, the lymphatic vessels are fewer in number; this is markedly the case with the cutaneous and subcutaneous vessels. The lymphatic glands, although abundant in the horse and ox, are less numerous in most other forms. Groups of glands in man are often represented by a single one or are wholly absent. Although this is the case, a vessel never joins the main trunk without first traversing one or more glands (Figs. 2281, 3284, and 3286). In the lowest mammals there is a strong tendency to symmetry in the lymphatic system, the right and left terminal trunks being more nearly equal in size, and in area from which the vessels come. This tendency is also marked in the horse, and especially so in the rabbit; it is frequently observed in the cat, and occasionally in man. The crossing of considerable trunks from one side to the other is more marked in the lower mammals than in the higher, but even in man considerable trunks not infrequently cross from one side to the other (Figs. 3264, also 3281, 3286); and in all the forms there is the closest possible relation between the two sides through the lymphatic plexuses, that is, networks formed by groups of lymphatic glands and their connecting lymphatic vessels. While it is not uncommon to speak of a network of lymphatic vessels as a plexus, the term is coming to be restricted rather to a lymphatic network in which the glands form the nodal points of the mesh (see Fig. 3263).

Of the animals below the mammalia, the birds possess few lymphatic glands, and these are mostly restricted to the neck. A cutaneous and subcutaneous lymph network has not been demonstrated in the birds. Those that have been shown, it is supposed, correspond with the ental and visceral lymphatics of mammals. The two trunks opening into the veins of the neck are symmetrical, that is, equal right and left trunks. There are also two openings for the lymphatics in the pelvic veins, and lymph hearts are found in this region, but they have muscular walls in only few adult forms (ostrich, cassowary, stork, and sea-gull), although they are contractile in the embryos of birds so far as investigated. Contractile lymph hearts are never present in man and the other mammals (but see below under Development). In addition to the birds mentioned, they are found in reptiles, amphibia, and some fishes. They are mostly situated in the pelvic region, and possess striated muscle which is paralyzed by curare like the skeletal muscles (Kölliker and Ranvier). In the tailless amphibia (Ranidæ) there is a pair of lymph hearts on the thoracic ducts as well as in the pelvic region; and with some elongated amphibia, *Salamandra maculosa* and *Siredon piscifórmis*, eight to twelve lymph hearts exist along the sides of the body and tail, at the junction of the dorsal and ventral body muscles. Finally, in some elasmobranch fishes the number of lymph hearts is very great (Sappey).

Below the birds the lymphatic glands are absent, their place being supplied by lymphoid tissue and by special fine vascular rete or networks into which the vessels break up in their course (Owen has described mesenteric glands in the crocodile). Perfect valves like those present in mammals are found in birds, less perfect ones in reptiles and amphibia, and finally in the fish-like forms none at all are found, so that the system may be injected toward the periphery like the arteries.

Topographical Anatomy of the Lymphatics.—While it would seem more philosophical to treat the various parts of the lymphatic system in their entirety throughout the whole body—viz., the ectal, superficial, or subcutaneous; the ental, subaponeurotic or deep, and the visceral lymphatics with the corresponding glands and lymphoid tissue—it is better practically, both for the purposes of demonstration and study, to consider all the lymphatic structures belonging to a given region at one time. This method is also really in accord with nature, because all the lymphatic structures in any moderately well-defined region of the body are, sooner or later, intimately associated and really form one whole for the given region.

Following the plan ordinarily pursued, the lymphatic vessels will be considered as extending in the direction in which their contents flow as with the veins, and also in order in which they must be demonstrated by injections. This will require the investigation to commence at the periphery and extend toward the centre. In the descriptions here given, usually only the trunks containing valves will be considered. The origin of the vessels in the tissues and the valveless networks will be considered below, under the origin and relations of the lymphatics. When the term plexus is used in this article it will be restricted to a lymphatic plexus composed of lymphatic glands with their connecting lymphatic vessels, and will not apply to a network of vessels without glands. After the vessels of a region have been de-

scribed, there will be given a list of the groups of the lymphatic glands and the plexuses belonging to the region, together with the source and destination of the afferent and efferent vessels. This will serve both to give the proper information concerning the number and position of the glands, and also to form a condensed summary of the lymphatic system in the region.

Lymphatic Vessels of the Head, Face, and Neck.—The ectal or subcutaneous lymphatic vessels of the head and face are very abundant and follow, in general, the course of the occipital, temporal, and facial blood-vessels, converging somewhat toward the great vessels of the neck; they traverse one or more of the lymphatic glands which form an irregular zone nearly around the base of the head (Fig. 3263), and finally enter the internal jugular plexus, and terminate in the thoracic duct on the left, or the common lymphatic trunk on the right (Fig. 3279). In addition to the general description just given, the lymphatics of the eyelids, nose, and ear require special mention.

The lymphatics of the eyelids and palpebral conjunctiva form a very abundant network, although it is somewhat difficult to demonstrate. Those from the conjunctiva wind round the edges of the lids and mingle with those of the integument, which are especially abundant at the edges of the lids. The branches unite into two great groups at the canthi of the lids, those at the lateral canthus extending to the parotid lymphatic glands, while those at the nasal canthus join those from the middle of the forehead and the nose, and extend to the submaxillary lymphatic glands (Fig. 3263).

The skin of the nose, especially the thicker part around the tip, where the large sebaceous glands are so abundant, is possessed of a very dense network of lymph capillaries and minute trunks. These trunks are joined by the abundant lymphatics from the vestibule, which in turn are continuous with the lymphatics of the nasal mucosa. Finally, the collecting trunks from the vestibule and the nasal integument extend obliquely across the face to the submaxillary lymphatic glands.

The lymphatics of the external ear and meatus form three principal groups: 1. Those of the helix, antihelix, and convex (posterior) surface. Those of the helix and antihelix wind round the free border of the ear to the convex surface, where they join the trunks of that surface, and uniting into several (four to five) considerable vessels, they extend to the mastoid lymphatic glands. 2. The lymphatics of the external auditory meatus, also the membrana tympani (see below), the concha and tragus, terminate by two or three trunks in the parotid lymphatic glands. 3. The lymphatics of the lobule unite into seven or eight considerable trunks which extend to the caudal or lower of the mastoid lymphatic glands.

Ental Lymphatics of the Face and Head.—These are exceedingly abundant, and extend mostly to the deep cervical glands, but the relations of the vessels and the terminal glands are so various that a special description is required for each of the principal organs. Nasal cavities and sinuses opening into them: The existence of lymphatic vessels in the nasal mucosa was not demonstrated until 1859, when E. Simon showed by successful puncture injections that they were numerous. He also showed their relation with the network of the naso-pharynx. The existence of these vessels has been verified by Sappey in man and numerous animals. According to Sappey, the demonstration is comparatively easy wherever the mucosa is of considerable thickness. Schwalbe, and later Key and Retzius, showed that the nasal lymphatics could be injected from the subdural space; Key and Retzius[2] further showed that the injection was equally successful from the subarachnoid space of the brain, the subarachnoid and subdural spaces of the myel (spinal cord). They also found that while in most cases the perineural sheaths of the olfactory nerves were injected at the same time, yet true lymphatic vessels did not communicate with these, but had special passages through the lamina cribrosa, and were often injected when the perineural sheaths were not injected; and sometimes the perineural sheaths were injected without the injection of the lymphatics. They were not successful in injecting the nasal lymphatics of man from the cranial lymph spaces, although the perineural sheaths of the olfactory nerves were in some cases filled. The freshly sacrificed dog and rabbit furnished the most successful preparations. The lack of success in man was

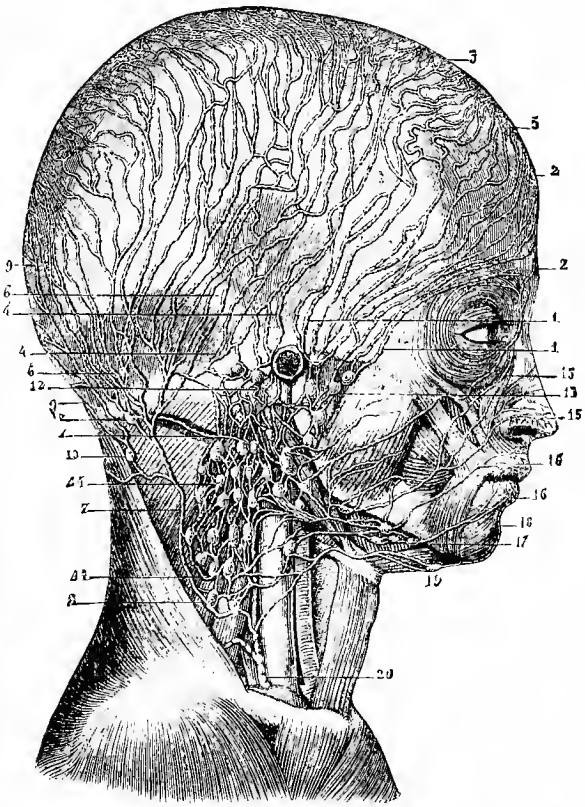


Fig. 3263.—Ectal Lymphatics of the Head and Face, the Ental Lymphatics of the Neck, and the Right Common Lymphatic Trunk. (Sappey[1].) 1, Lymphatics from the frontal region going to the parotid lymphatic glands; 2, 2, vessels arising near the middle of the forehead, the upper ones going to the parotid, the lower ones to the submaxillary lymphatic glands; 4, 4, vessels from the parietal and temporal region extending to the mastoid lymphatic glands; 6, 6, vessels from the parietal and occipital region joining the occipital plexus; 7, trunk from occipital plexus to the supraclavicular glands; 8, trunk from the occipital to the cephalic ental (superior deep) cervical glands; 10, 10, occipital lymphatic glands; 11, cephalic ental (superior deep) cervical glands and plexus; 12, mastoid glands; 13, parotid lymphatic glands; 14, part of supraclavicular glands; 15, 15, lymph vessels from the nose to the submaxillary glands; 16, 16, lymphatics from the lips to the same glands; 17, submaxillary glands; 18, vessel from the lip to 19, the supra-hyoid gland; 20, right common lymphatic trunk opening into the veins at the angle formed by the junction of the subclavian and internal jugular veins.

attributed to the inability to obtain sufficiently fresh material; it was also suggested that in man the lymph from the cranial lymph spaces might have a sufficient number of other outlets.

The lymphatic network covers the entire nasal mucosa, both on the olfactory and the respiratory part, and that lining the septum. In man this network is directly continuous with that of the vestibule of the nose, but the collecting trunks extend toward the pharynx. The network is also continued into the frontal, and presumably the other, sinuses opening into the nasal fossæ. As they approach the pharynx, the collecting trunks of the nasal mucosa are continuous with those of the dorsal surface of the soft palate and of the pharynx, especially the dense network around the Eustachian orifice. From

these situations the collecting trunks accompany those of the soft palate and the pharynx, sending one trunk through the wall of the pharynx to the large lymphatic gland ventrad of the atlas. This gland, according to Sappey, is the most cephalic (superior) of any in the body, and becomes involved in diseases of both the nose and the pharynx. The other trunk traverses the pharyngeal wall, and extends along the neck to the level of the perforation of the sterno-mastoid muscle by the accessorius nerve, where it bifurcates and enters the two deep cervical glands, covered by the sterno-mastoid muscle at this point. No doubt, also, minute branches join the palatine trunks which follow the posterior pillars of the fauces, and enter the deep cervical glands near the thyrohyoid ligament (Plate XLII., 13). In the dog all the lymphatics from the nasal mucosa are shown by Key and Retzius as entering the deep cervical glands (3, 3, of Fig. 3285). Sappey figures and describes the exceedingly abundant lymphatics of the nasal mucosa in the horse and ox. In both these animals, but especially in the horse, the lymphatics of the mucosa lining the nasal septum are very abundant, and in both animals, besides the trunks extending toward the pharynx, there are large trunks extending toward the prenares, where they become subcutaneous, and extend with the ectal facial vessels to the submaxillary lymphatic glands.

Lymphatics of the Eye and the Orbit.—The lymphatics of the palpebral conjunctiva wind round the edge of the eyelid, and join those of the integument as described above, and finally reach the parotid and submaxillary lymphatic glands. Sappey denies the presence of lymphatics in the eyeball itself, but most anatomists consider that, while the eye may not be supplied with numerous independently walled lymphatics, nevertheless it is abundantly supplied with lymph passages, etc., many of which have an endothelial lining. The lymph channels of the cornea, which are exceedingly abundant, following the nerves as well as the corneal corpuscles and their co-anastomosing processes, communicate with the conjunctival vessels, and also with the lymph clefts of the sclerotic; the aqueous chamber also communicates indirectly with the conjunctival lymphatics through the cornea. In the suprachoroidea have been described distinct anastomosing lymphatic vessels by Altmann, and their presence has been lately confirmed by one of his pupils.[3]

The retinal blood-vessels are well supplied with perivascular lymph spaces like those of the central nervous system, and may be injected from the lymph spaces of the optic nerve. Both chambers of the eye and the perichoroidal, and the space enclosed by the capsule of Tenon, and the lymph spaces of the optic nerve, all communicate; and as shown above, the corneal spaces, and the aqueous chamber through the cornea, communicate on the one hand with the conjunctival lymphatics, and on the other with the lymph clefts in the sclerotic. In accordance with this complicated relation of the lymph paths of the eye, the lymph streams have been likewise found of equal complexity—passing from the vitreous to the papilla optici, and along the central canal of the optic nerve with the blood-vessels, and ultimately reaching the cranial cavity. This has been shown to be the direction in the cat, dog, rabbit, and guinea-pig, and is supposed to be also the case in man. There is also a stream flowing from the subarachnoid and subdural spaces in the cranium, which follows the prolongations of those spaces around the optic nerve; these finally reach the eye and communicate with its various lymph spaces, and through the perichoroid space with the lymph space in the capsule of Tenon, and presumably through this with the lymphatic vessels in the orbit. That is, there is a lymph stream flowing from the eye to the cranial cavity, and another from the cranial cavity back to the eye through a different channel.[4] If the assumption is correct, that the lymphatics of the eyeball communicate through the capsule of Tenon with the lymphatics of the structures in the orbit, their destination is to the lymphatic glands of the ental cervical group in the sphenomaxillary fossa. Through the cranial cavity the lymph from the eye might also extend with the lymph of the subarachnoid and subdural spaces to any point with which these spaces communicate. (See lymphatics of the central nervous system, below.)

Lymphatics of the Ear.—The lymphatics of the membrana tympani are like the blood-vessels in three layers, corresponding to the cutis, the mucosa, and the intermediate fibrous framework. They extend to the external auditory meatus and, joining these, finally enter the parotid lymphatic glands, as described above for the external ear. Those of the tympanum or middle ear are numerous, but apparently confined mostly to the submucosa. They are directly continuous with the lymphatics of the Eustachian tube, and extend with them to the abundant network in the pharynx around the Eustachian orifice, and finally extend to the ental cervical lymphatic glands. The lymphatics of the internal ear consist mostly of spaces which are in communication with the subarachnoid and subdural spaces through the perineural spaces of the auditory nerve, thus agreeing with the eye and nose.

Lymphatics of the Mouth, Pharynx, and Larynx.—The immense richness of the lymphatic network in these regions, their connection with the nose, and through the

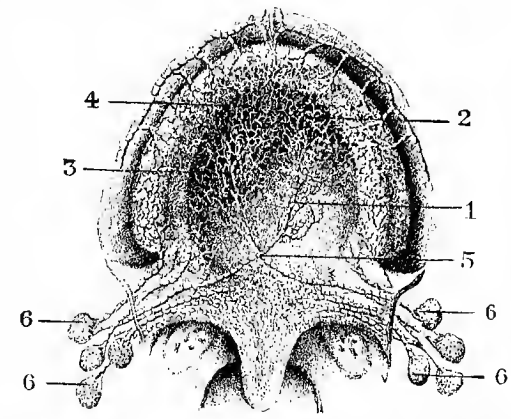


FIG. 3264.—Lymphatics of the Roof of the Mouth and the Gums in a Child at Birth. (Sappey, Atlas.) 1, The lymphatics injected by one puncture at 2; the trunk formed on the right crosses to the left, and those from the left to the right. Crossings of the lymphatics in man are most frequent in this situation, according to Sappey. In the lower animals such intercrossing is not infrequent; 2 and 4 point where the cannula was inserted to make the injections; 3, lymphatics of the gums, connected on one side with those of the palate and on the other with those of the cheeks, the trunks usually extend with those of the cheeks to the submaxillary lymphatic glands, those nearest the parotid lymphatic glands frequently enter them instead of going to the submaxillaries; 5, crossing point of the trunks from the roof of the mouth; 6, 6, group of ental cervical glands near the bifurcation of the common carotid.

nose with the cranial lymph spaces, with the middle ear, œsophagus, and trachea, and the varied termination of the collecting trunks, give the lymphatics of this group an especial anatomical interest. They are not less important pathologically from their involvement in the grave disorders of the mouth, nose, and throat.

The lymphatic network of the buccal mucosa, gums, roof, and floor of the mouth, palate, and pharynx, may be said to be continuous, but the collecting trunks in different regions have quite different destinations. At the lips the network is also continuous with that of the integument, but the course of the lymph stream is away from the lips. For the gums of the maxilla or upper jaw, the lymphatics extend between the teeth and join those of the mucosa of the cheek; these follow in general the contour of the jaw and penetrate the cheek at various points, extend in part to the parotid lymphatic glands, but mostly to the submaxillary glands. Nearer the pharynx they join the palatine lymphatics (Fig. 3264). A large number of those from the gums of the

lower jaw join the lymphatics of the cheek and extend to the submaxillary lymphatic glands. A part also join those of the pillars of the fauces.

The lymphatics of the hard and soft palate, while directly continuous with those of the gums, have a direction toward the pharynx, the trunks of the two sides often crossing. They join those of the pillars of the fauces, and go with them to the ental cervical glands near the larynx (Fig. 3264; Plate XLII.). Some also extend to the glands near the bifurcation of the common carotid with the trunks from the soft palate (Fig. 3264). The lymphatics of the soft palate on the pharyngeal or superior surface are only moderately developed, and communicate with those from the nose and from the Eustachian tube; the collecting trunks extend in part along the posterior pillar of the fauces to enter the glands along the larynx (Plate XLII., 13). But a greater number of collecting trunks pass laterad and penetrate the pharyngeal walls to enter the gland on the ventral aspect of the atlas. The ventral or lower face of the soft palate differs from the dorsal or upper face in having a greater number of lymphatic vessels, and the uvula is so richly supplied that it appears almost like erectile tissue, increasing two or three times in volume when successfully injected. The collecting trunks from the uvula and ventral aspect of the soft palate extend along the two pillars of the fauces, and join the trunks from the base of the tongue; but the greater number pass laterad through the wall of the pharynx and extend to the ental cervical lymphatic glands around the bifurcation of the common carotid.

The lymphatics of the tongue escaped discovery until 1847, when Sappey demonstrated them. They are difficult to demonstrate in the adult on account of the number and calibre of the veins, but in the infant and child the veins cause less trouble, and the lymphatics are easily injected. They form a rich network over the entire free surface to a point slightly beyond the circumvallate papillæ. Around the circumvallate papillæ they reach their greatest development. Up to the present no lymphatics have been demonstrated as arising in the substance of the tongue itself, the vessels traversing the tongue being collecting trunks from the mucosa. Around the edges of the tongue the network of the dorsal and ventral surfaces freely anastomose. But the main course of the collecting truncules is toward the middle, on the dorsal side, and toward the base. A few small trunks penetrate the tongue and after traversing the lingual glands, when those are present, extend to the ental cervical glands near the bifurcation of the common carotid. Most of the trunks, however, continue along the dorsum of the tongue, unite into large trunks beyond the circumvallate papillæ, and extend in a wide curve to the ental cervical lymphatic glands situated near the thyro-hyoid ligament (Plate XLII., 13). The lymphatics on the ventral side of the tongue extend mostly through the substance of the organ, traversing the lingual glands when present, and finally extend with those which penetrate from the dorsal side, to the lymphatic glands around the bifurcation of the common carotid.

The tonsils, although composed of lymphoid tissue, were not shown to possess a lymphatic network until Sappey succeeded in demonstrating it, in 1876. This network, which covers the surface and extends into the depths of the tissue, is much more easily injected in the new-born child than in the adult. The network anastomoses with that of all the surrounding structures, and the collecting trunks pass with those from the tongue and pillars of the fauces to the glands next the thyro-hyoid ligament (Plate XLII.). The lymphatics of the pharynx also resisted demonstration for a long time. They were found by Sappey to be directly continuous with those of the bordering structures, and while the trunks all communicate at their origin, there are three groups on each side: 1. A dorsal group extending along the dorsal or posterior wall of the pharynx nearly to the postnares, and then turning laterad and penetrating the pharyngeal wall, enters the gland on the ventral side of the atlas. 2. Several lateral trunks which extend along the side of the larynx and enter the lymphatic glands near the thyro-hyoid ligament. 3. Several ventral trunks extending mostly in a caudal (inferior) direction to join the supraclavicular lymphatic glands along the œsophagus and trachea.

Larynx.—The lymphatics of the larynx form one of the densest networks known in the body. Commencing with the epiglottis the number is almost infinite, the appearance being as if all the soft structures were composed of nothing but lymphatics. With the infant the abundance of lymphatics is continued without interruption along the trachea; but as age advances, the network in the larynx quite suddenly diminishes, so that, commencing with the vocal cords, the network in the larynx and trachea is comparatively slight. From the epiglottis, vestibule of the larynx, the sinus or ventricle, and the vocal cords, collecting trunks extend through the lateral wall of the vestibule, perforate the thyro-hyoid membrane, and terminate in the ental cervical glands beside the larynx (Plate XLII., 13).

Lymphatics of the Central Nervous System.—The spaces and membranes of the brain and the myel are so directly continuous that a discussion of the lymphatics of both seems desirable. Sappey denies lymphatics to the entire nervous system, both central and peripheral, but this is not in accordance with most observers who have made special investigations upon the subject. It is true that independent vessels with definite walls are not found to exist in the nervous substance proper; but from the investigations of Kölliker, Virchow, Robin,[5] and Key and Retzius, it has been shown that, in the nervous substance of the brain and myel, the blood-vessels ramifying in it are possessed of a loose adventitia which is continued from the pia, the so-called pial funnels; and in the meshes of this adventitia are long spaces, like those around the blood-vessels of reptiles. It is supposed that these communicating spaces form the lymph passages of the nervous substance. They may be injected for a considerable distance into the nervous substance from the subarachnoid space, and injections by the puncture method into the nervous matter not infrequently fill these passages, and extend into the subarachnoid space. After reviewing carefully all the evidence, Key and Retzius[2] consider the perivascular space of His—that is, a space entirely outside all the walls of the blood-vessel—as an artifact, as is also the presence of a subpial lymph space into which it opens. From the standpoint of Key and Retzius, then, the nervous matter of the central nervous system is drained of its lymph through the adventitial lymph spaces of its blood-vessels, and these spaces open into the subarachnoid space.

The lymphatics of the meninges are still in some doubt. In the dura there are wide-meshed, often ampulliform, vessels with endothelial walls that are supposed by some to be true lymphatics. Although their form is so strikingly like lymph vessels, Key and Retzius found, on making the crucial test, that they communicate with the blood-vessels and do not extend to lymphatic glands. There are, however, in the dura a great number of elongated clefts which are probably lymph clefts or channels. In the pia a very distinct and undoubted network of lymph vessels has been described and figured. It is probably largely through these that the lymph of the subdural and subarachnoid spaces is drained away.

The subarachnoid space communicates directly with the neurocœle (ventricles of the brain) through the foramen of Magendie, and both the subarachnoid and subdural spaces of the optic, auditory, and olfactory nerves, and, in fact, all the nerves arising from the brain and myel, except that in the ordinary nerves the arachnoid as a special membrane soon disappears, and the subdural and subarachnoid spaces become one.

The ento-cranial lymphatics converge to form larger and larger trunks. Those from the vascular plexuses or telas accompany the *vena magna Galeni* to the base of the brain, where they are joined by the lymphatic trunks

from the surface of the brain. The combined trunks follow the great blood-vessels out of the cranial cavity mostly through the jugular foramen, and enter the deep cervical lymphatic glands. Small trunks are described as traversing the spinous and oval foramina with the middle meningeal vessels, finally to enter the ental cervical glands in the spheno-maxillary fossa; but the existence of these lymphatic trunks is disputed.

As stated, the subarachnoid and subdural spaces of the brain are directly continuous with the corresponding spaces of the myel, and are also projected out with the nerves, most completely with the optic, auditory, and olfactory, and in this way communication is gained with the lymphatics of the structures to which the nerves are distributed.

The exact relations of the ento-spinal lymphatics do not seem to have been well worked out, but they are described as following the blood-vessels, and terminating in the glands in course of the blood-vessels which they follow. The lymphatics of the central nervous system then extend to all great groups of glands in the neck and trunk.

Lymphatics of the Neck.—These are ectal and ental (superficial and deep), and include the lymphatics of the structures of the neck proper, and also all the trunks from the head and face. The vessels from the integument extend mostly to the ectal cervical glands, but part of them enter the supraclavicular glands directly (29, 29, of Fig. 3269).

Lymphatic Glands of the Head and Neck.—These are very numerous and important. They are all confined to the sides of the face, around the base of the head, none having been found within the skull, and along the great cervical blood-vessels. They have been divided into two great paired groups or plexuses, the ectal or external, and the ental or internal jugular lymphatic plexuses; the ectal jugular plexus including all the ectal glands and finally pouring its lymph into the ental plexus, which includes all the ental cervical glands. This, while communicating with the glands in the thorax and axilla, sends a main efferent trunk, *truncus jugularis*, to join the thoracic duct on the left, the common lymphatic trunk on the right; or in some cases the jugular trunk ends partly or wholly independently in the veins (4 and 5 of Fig. 3283). These plexuses form a kind of double and closely connected chain along the course of the great cervical vessels, and yet, for convenience of description and reference, they have been described as several groups; but here, as in other parts of the body of man, the groups merge so insensibly into each other that the same gland might be placed in one group by one anatomist, and in the adjoining group by another. Furthermore, it should not be lost sight of that from a limited region lymphatics may go to quite widely separated groups of glands, and also that the number and size of the glands in a group are subject to considerable individual variation. (For examples, see Fig. 3268 B. and 3276, also the description of the lymphatics of the liver, Fig. 3273.)

Fig. 3265.—General View of the Head, Neck, and Thorax, also the Termination of the Thoracic Duct. (Mascagni.) 1, Thoracic duct as it emerges from the thorax opposite the first rib; 2, termination of the thoracic duct at an angle formed by the junction of the subclavian and internal jugular veins. In the original folio plate there is a considerable swelling shown on the thoracic duct about 15 mm. before its termination. At the lower part of the figure is the arching diaphragm with vessels extending to the sternal glands; the heart is displaced to the left from the opened pericardium. This cut does scant justice to the beautiful original, in which every detail is clear and clearly marked by letters or numerals.

The ectal glands of the head and neck, *i.e.*, the glands of the ectal or external jugular lymphatic plexus, are divided into the five following groups:

1. The occipital lymphatic glands (*glandulæ lymphaticæ occipitales, s. suboccipitales*), one or two, usually small glands on the complexus muscle between the cranial attachment of the trapezius and the sternomastoideus. The afferent vessels are from the occipital, partly, also, from the temporal and parietal regions; the efferent vessels extend partly to the ectal cervical, and partly to the supraclavicular glands (Figs. 3263 and 3265).

2. Parotid lymphatic glands (*glandulæ lymphaticæ parotideæ, s. auriculares anteriores, s. faciales superficiales, s. zygomaticæ*). There are usually ten to twelve of these on the surface and in the substance of the parotid salivary gland. The afferent vessels are from the temporal and frontal regions, the sides of the face, lateral part of the eyelids and conjunctiva, concha, tragus, membrana tympani and external auditory meatus of the ear; from part of the mucosa of the cheeks and the gums of the maxilla or upper jaw. The efferent vessels pass to the submaxillary and ectal cervical lymphatic glands.

3. Mastoid lymphatic glands (*glandulæ lymphaticæ mastoideæ, s. subauriculares, s. auriculares posteriores*). Several small glands on the cranial attachment of the sternomastoid muscle, near the mastoid process and base of the ear. The afferent vessels are from the parietal, temporal, and occipital regions in part, from the helix, antihelix, convex surface, and lobule of the ear. The efferent vessels extend to the ectal and ental cervical glands.

4. Submaxillary lymphatic glands (*glandulæ submaxillares*). There are several of these extending along almost the entire extent of the body of the mandible. In this group are included the glands on the buccinator muscle, sometimes described as a separate group (glandulæ buccales, s. buccinatores) and sometimes classed with the ental glands. The submaxillary glands extending near the chin are also sometimes called submental, and a single one near the meson has been named suprahyoid by Sappey. The afferent vessels of this group are from the middle of the forehead, the nasal canthus of the eye, the integument of the nose and vestibule, and in the horse and ox also partly from the nasal fossæ; from the cheeks and lips, the gums of the mandible in part, and the floor of the mouth, part of the efferent vessels from the parotid lymphatic glands; the efferent vessels pass to the ectal and ental cervical glands.

5. Ectal cervical lymphatic glands (*glandulæ lymphaticæ cervicales ectales, s. superficiales, s. jugulares superficiales*). Several small glands along the ectal jugular vein, but extending on both sides of it. They are between the platysma and the sternomastoid muscles. The afferent vessels are from the ectal structures of the neck, part of

the efferent vessels from the occipital, parotid, mastoid, and submaxillary groups; efferent vessels extend to the supraclavicular glands.

The ectal or external jugular lymphatic plexus in the larger animals—horse and ox—is approximately like that of man; but in the rabbit it is represented only by the submaxillary lymphatic glands and two small glands near the ear (3 and 4 of Fig. 3286). In the dog only the submaxillary lymphatic glands seem to belong to this plexus (3 of Figs. 3281 and 3284); in the cat the mastoid glands are large and may be injected from the inner or concave aspect of the external ear. It is possible that the small gland on the trunk following the external jugular vein, shown in Fig. 3282, may also belong to the ectal plexus. One cannot help being struck with the fewness of the glands in the dog, cat, and rabbit.

The ental glands of the head and neck, or the glands of the ental jugular plexus are situated on the course of the great vascular trunks and extend from the atlas to the thorax. The lymphatics of the entire head and neck ultimately traverse this plexus.

The glands of this plexus have been quite commonly divided into three great groups, with some minor groups —the deep facial, the superior and inferior deep cervical; but in actual descriptions of the lymphatics of the various organs the anatomists of the present day, although they recognize three groups, and some of them minor groups, actually divide all the glands of the ental jugular plexus into two groups, viz., those extending from the level of the base of the cranium, along the deep vessels, to the bifurcation of the common carotid, and those from the bifurcation of the carotid to the junction of the jugular and subclavian veins. This division was adopted in the previous description, and has been called (1) ental cervical, and (2) supraclavicular. (1) Ental cervical lymphatic glands (*glandulæ lymphaticæ cervicales entales, s. profundæ, s. glandulæ lymphaticæ jugulares cephalicæ*). The ental cervical, or jugular group of glands, includes all the ental glands around the deep structures from the bifurcation of the common carotid artery nearly to the base of the skull, and includes the glands on the internal maxillary vessels in the sphenomaxillary fossa, which are usually given a separate group under the name of deep facial or internal parotid, internal maxillary, etc. It also includes the glands generally grouped as the superior jugular or superior deep cervical.

The glands in this group are numerous and quite widely separated from one another, extending from the ventral face of the atlas to the side of the larynx, being about as variously arranged as the organs of this region. The one between the atlas and pharynx is said to be the most cephalic of all the lymphatic glands of the body.

The afferent vessels of this group are from the orbit, nasal cavity, the cheek, roof and floor of the mouth, in part from the tongue, pharynx, tonsil, tympanum, and Eustachian tube, the larynx, the thyroid, and the brain and its membranes. The efferent vessels pass to the supraclavicular glands.

(2) The supraclavicular glands (*glandulæ lymphaticæ supraclaviculares, s. cervicales profundæ inferiores, s. jugulares inferiores*). These glands are arranged along the carotid artery and internal jugular vein from the bifurcation of the common carotid to the junction of the subclavian and internal jugular veins. All the efferent trunks from the ectal jugular plexus and from the ental cervical glands enter this group, also many of the lymphatics of the pharynx, œsophagus, trachea, the lymphatics accompanying the vertebral artery and vein, also some of the ectal and ental lymphatics of the neck and the clavicular region. They also communicate with the anterior mediastinal and with the axillary glands. The efferent vessels form a single or multiple trunk (*truncus lymphaticus jugularis*) and terminate on the left in the thoracic duct, or on the right in the right common lymphatic trunk, or sometimes partly or wholly by an independent opening into the great veins (Figs. 3263 and 3283).

In the horse and ox the glands of the neck are approximately like those of man; but in the cat, dog, and rabbit there is but a single ental cervical lymphatic gland, and the jugular trunk is usually large and long, and not infrequently opens partly or wholly into the vein independently (Figs. 3282, 3283, 3285, and 3287).

Lymphatic Vessels of the Thoracic Limb (Arm and Shoulder).—The lymphatics of the arm and shoulder form an ectal and ental set, as in most parts of the body. The lymphatics of the hand arise by a complex network on the dorsal and palmar surface of the fingers, and extend toward each side of the finger, where they unite into two or three anastomosing trunks which follow the direction of the collateral arteries to the hand when they reach the dorsal surface. From the palm many vessels wind round both edges to the dorsal side also; but many next the wrist extend directly upon the ventral or flexor aspect of the arm and extend to the axillary region. The trunks on the dorsum of the hand and the extensor side of the entire arm gradually wind round to the flexor surface in their course to the axilla. Most of the vessels enter directly the axillary glands, but a few of those from the fourth and fifth fingers and the ulnar side of the antibrachium traverse one or two glands (ectal brachial or supra-epitrochlear glands in the flexure of the elbow, Fig. 3267) before proceeding to the axillary glands. Frequently, if not constantly, one or more trunks follow the cephalic vein and go to the subclavian glands instead of going to the axilla, and not infrequently there is a gland in the course of these near the insertion of the deltoid, or even farther along (13 of Fig. 3267; see also Fig. 3269).

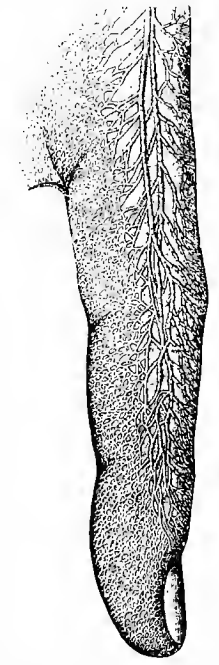


FIG. 3266.—Ectal Lymphatics of a Finger. (Sappey.) To show the extreme abundance of the lymphatics and the fineness of the network on the end and the palmar aspect, also that the vessels from both the dorsal and ventral surfaces extend to the side where two or three considerable trunks, parallel with the collateral artery, convey the lymph toward the hand. By comparing Fig. 3267, it will be seen that these trunks always extend upon the dorsum of the hand.

The ectal lymphatics of the shoulder either join the trunk following the cephalic vein or extend round to the axilla. The ental lymphatics of the arm arise in the deep structures and follow the principal blood-vessels much more closely than do the ectal lymphatics. In the antibrachium there are, therefore, three groups following the radial, ulnar, and interosseous blood-vessels. There are occasionally a few small lymphatic glands in the antibrachium (antibrachial glands) through which a part of the vessels pass; but usually none are reached until in the flexure of the elbow, where, extending along the brachial vessels, there are regularly met three or four glands (ental or deep brachial glands), which most of the vessels traverse. Before reaching the axillary glands, according to most authors, there is a free anastomosis between the ectal and ental lymphatics at the wrist and elbow, but Sappey denies any such anastomosis.

According to the description of most veterinarians, the lymphatics of the arm and shoulder of the horse and ox are quite comparable with those of man both as to glands and vessels, except that there is a larger lymphatic gland in the fold between the scapula and the neck—the prescapular gland. In the dog and cat the arrangement is exceedingly simple. All of the vessels, except a few cutaneous ones whose course is somewhat irregular,

which can be injected from the pads of the manus (fore-paw), finally extend upon the dorsum of the paw, and extend from there by two or more frequently anastomosing trunks along the radial nerve to the elbow, and then follow the cephalic vein to the prescapular gland, no axillary glands being present (Figs. 3281 and 3284). Occasionally, in the cat, one or more branches turn in the bend of the elbow to follow the brachial vessels to the axilla, and finally enter the nearest pectoral gland.

In the rabbit, vessels likewise follow the radial nerve to the elbow, then extend obliquely around the radial side of the brachium to the axillary glands. Other trunks follow the large blood-vessels, and enter the axillary glands. The lymphatic vessels of the arm, whatever their course, traverse but a single gland in the dog and cat, sometimes two glands in the rabbit.

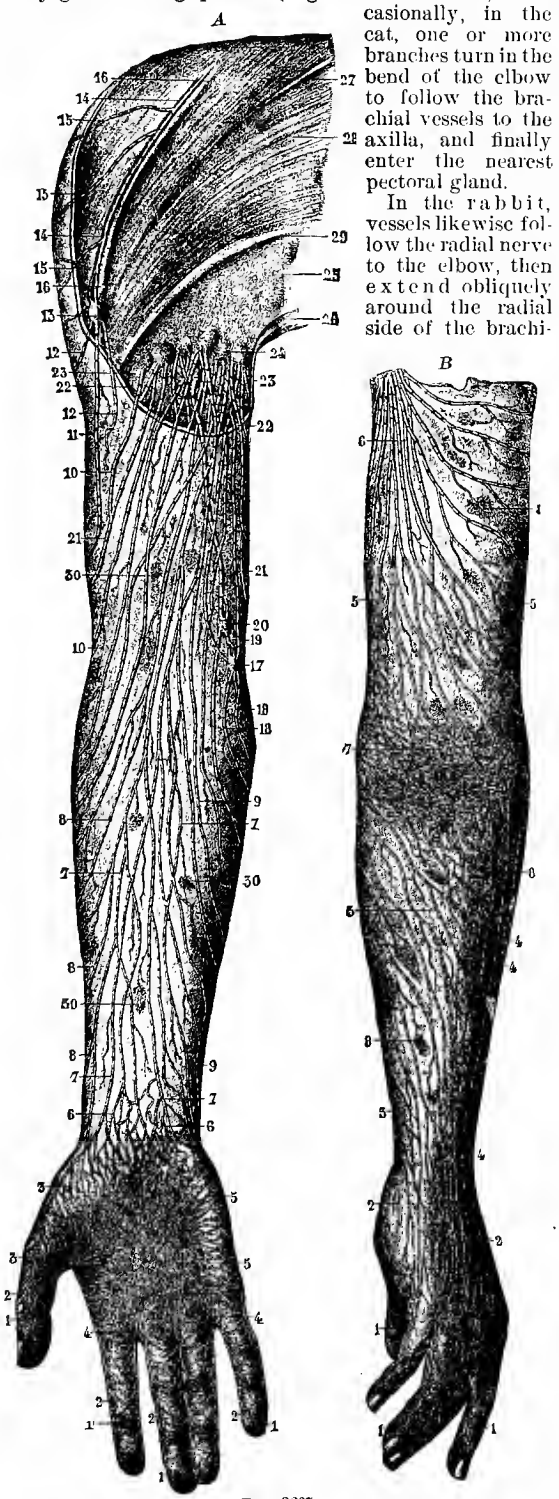


FIG. 3267.

LYMPHATIC GLANDS OF THE ARM AND SHOULDER.—Ectal brachial glands (*glandulæ brachiales ectales, s. superficiales, s. cubitales superficiales, s. supratrochleares*), two glands often found in the course of part of the trunks from the fourth and fifth fingers and the ulnar side of the arm. The gland in the course of the trunk following the cephalic vein has not been named.

The ental glands. There are sometimes a few in the antibrachium (*glandulæ lymphaticæ antibrachiales*), through which traverse the ental antibrachial lymphatics, on their way to the ental brachial glands (*glandulæ lymphaticæ brachiales entales, s. profundæ, s. cubitales profundæ*). These are just proximal of the elbow-joint on the brachial vessels. Through them pass part of the ental lymphatics.

The axillary lymphatic glands (*glandulæ lymphaticæ axillares*, Fig. 3269) are situated in the axillary region around the great vessels and nerves, and covered by the pectoral muscles and extending from the edge of the great pectoral into the subclavian fossa, where they are in communication with the supraclavicular glands. All the lymphatic vessels of the arm and most of those of the shoulder enter these glands; also many from the supra-umbilical part of the abdomen, side, and back; also the lymphatics of the mammary gland and the other structures of the breast, including the efferent vessels of the pectoral lymphatic glands. The efferent trunk (*truncus*

FIG. 3267.—Ectal Lymphatics of the Hand and Arm. (Sappey, Atlas.) To show the number and course of the trunks, and the fineness of the network in the hand and arm. Except a small area around the shoulder and in the axilla where the skin is removed, the lymphatics are represented as if the skin were transparent. *A*, Ventral aspect of the right arm. 1, 1, Network of lymphatics on the palmar aspect of the fingers; 2, 2, the collateral trunks on each side of the fingers—the collecting truncules from both palmar and dorsal side wind round the finger to the edge and, uniting into two or more trunks (Fig. 3266), extend upon the dorsum of the hand; 3, 3, trunks coming from the palm to join those from the thumb; 4, 4, collecting trunks from the distal part of the palm which wind round between the fingers to reach the dorsal surface (see *B*); 5, 5, collecting trunks at the ulnar side of the hand, likewise winding round upon the dorsal surface; 6, 6, collecting trunks from the palm next the wrist—they extend directly along the flexor aspect of the arm; 7, 7, large trunks formed by the union of many of those from the palm and thumb; 8, 8, trunks winding round the radial side of the antibrachium from the extensor to the flexor side; 9, 9, similar trunks winding round the ulnar side of the antibrachium, from the dorsal or extensor to the ventral or flexor side; 10, lymphatic trunks curving round from the dorsal or extensor to the ventral or flexor side of the brachium to enter the axillary glands; 11, trunk following the course of the cephalic vein and traversing the gland at 13; 12, 12, trunks winding round the arm and shoulder to join the gland on the cephalic vein; 14, 14, lymphatic trunk accompanying the cephalic vein and entering the subclavian glands; 15, vessels from the scapular region to the trunk accompanying the cephalic vein; 16, cephalic vein in the furrow between the deltoid and pectoral muscles; 17 and 20, ecto-brachial or supra-epitrochlear lymphatic glands—through these pass part of the vessels from the little finger and the ulnar side of the arm; 18, 19, trunk entering the more distal and joining the two glands—the efferent trunk from 20 is one of the largest of the arm, it penetrates the tissues and accompanies the basilic vein to the axillary glands; 21, 21, collecting trunks extending toward the axilla; 22, 22, cut edge of the skin; 23, 23, brachial aponeurosis; 24, axillary lymphatic glands showing through the aponeurosis; 25, axillary aponeurosis covering the glands; 26, border of the axillary space formed by the teres and latissimus muscles; 27, clavicular fascia of the pectoralis separated from the deltoid by the groove containing the cephalic vein with its accompanying lymphatic trunk; 28, sternal fascia of the pectoralis; 29, border of the pectoralis, forming also the border of the axilla; 30, 30, 30, points on the brachium and anti-brachium where the fine network of vessels has been injected—in a completely injected preparation the entire skin would be covered with such a network. *B*, Ulnar side of the hand and extensor aspect of the antibrachium and part of the brachium, to show that the trunks from the fingers and palm extend largely upon the dorsal aspect and then wind round the arm to reach the ventral or flexor aspect. 1, 1, 1, Lymphatics of the fingers, the collecting trunks extending upon the dorsum of the hand; 2, 2, vessels on the dorsum of the hand; 3, 3, lymphatic trunks winding round the ulnar side of the antibrachium to reach the flexor aspect; 4, 4, 4, vessels winding round the radial side of the antibrachium to reach its flexor surface; 5, 5, vessels on the brachium curving round to the axilla; 6, group of vessels converging toward the axillary lymphatic glands; 7, lymphatic network at the convexity of the elbow; 8, 8, 8, spots in which the fine lymphatic network of origin is shown.

subclavius) is one of the important tributaries of the common lymphatic trunks. As here used the axillary group of glands includes the subclavian or infraclavicular glands into which flow the trunks following the cephalic vein. By some authors the pectoral glands are also included in the axillary group (Quain).

In the dog and cat no axillary glands are present, all the trunks going to the prescapular gland (*glandula prescapularis*) (Figs. 3281–3285). In the rabbit all go to axillary glands more nearly as in man (Figs. 3286 and 3287).

Lymphatic Vessels of the Pelvic Limb.—The ectal lymphatics of the foot, leg, and thigh are almost precisely like those of the hand and arm. The vessels of the toes and sole extend mostly to the dorsum of the foot, and then wind round the leg to the inguinal region, and enter the subcutaneous inguinal lymphatic glands (Figs. 3268 and 3269). A limited number of vessels from the heel and fibular side of the foot accompany the short saphenous vein to the popliteal space where they enter the popliteal glands and join the ental lymphatics.

The subaponeurotic or ental lymphatics also resemble those of the arm, following the main vascular trunks; hence in the crus there are three groups: one on the extensor side of the crus following the anterior tibial vessels, and sometimes traversing one or two anterior tibial glands at about the middle of the crus. The lymphatics penetrate the interosseous ligament near the knee to enter the popliteal glands. The other two groups follow the peroneal and posterior tibial blood-vessels to the popliteal glands. After traversing the popliteal glands the lymphatics follow the femoral vessels to the inguinal region, where they enter the ental inguinal glands and after traversing these accompany the femoral vein and artery into the abdomen to the iliac glands. Besides these there are lymphatic trunks accompanying the sciatic and gluteal vessels, which traverse one or more small glands, gluteal and ischiatic glands, at the sacrosciatic foramen and then enter the hypogastric glands. The trunk following the obturator artery constantly traverses, according to Cruveilhier, a considerable gland (*glandula foraminis obturatorii*) before entering the hypogastric glands.

In the dog, cat, and rabbit there is the same simplicity of the lymphatic trunks as pointed out for the arm. Injections into the pad of the pes (hind

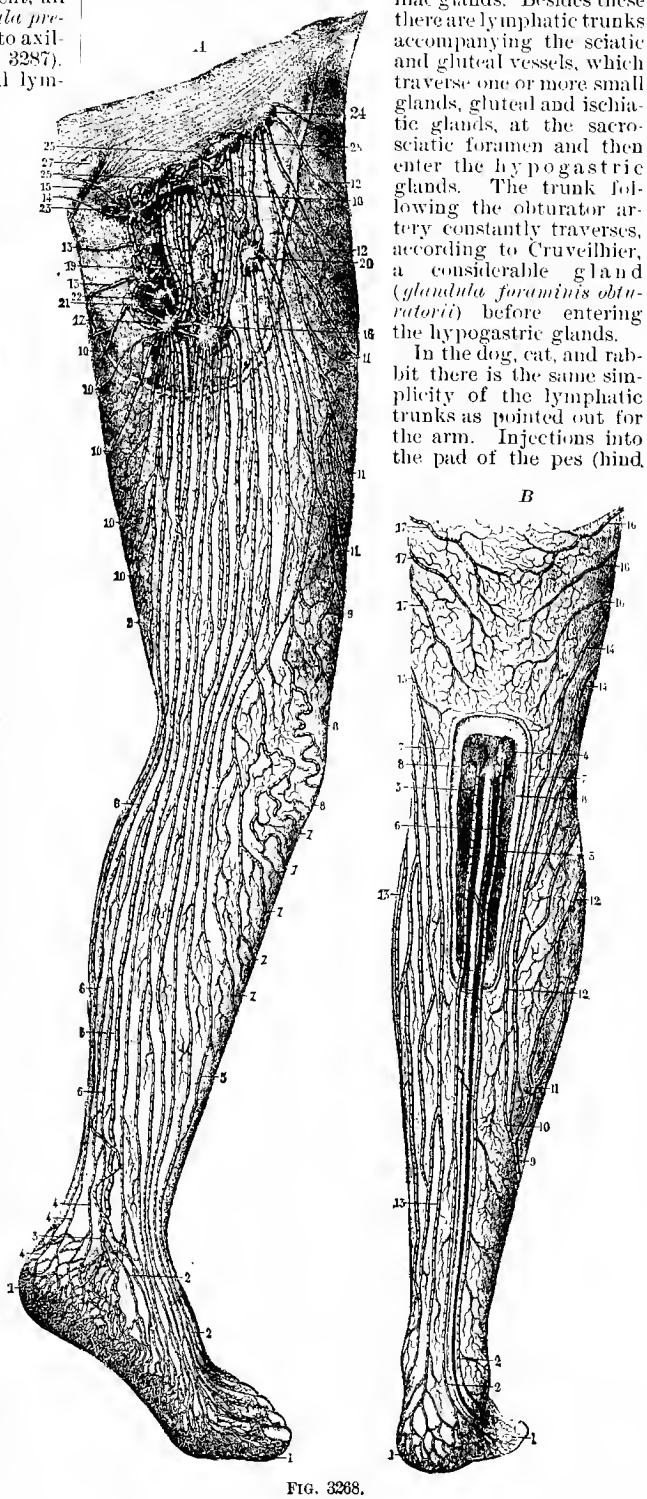


FIG. 3268.

FIG. 3268.—Ectal Lymphatics of the Foot and Leg, to show the Origin, Number, and Course of the Lymphatic Trunks, and the Popliteal and Inguinal Lymphatic Glands. The skin is represented as transparent, except where removed in the popliteal space and in the inguinal region. (Sappey, Atlas.) *A*, The tibial side of the foot and entire leg. 1, 1, Tuncules arising from the sole, great toe, and side of the foot; 2, 2, trunks arising at the toes and extending across the dorsum of the foot to reach the tibial side of the leg; 3, great trunk arising from the plantar aspect near the instep, and skirting the tibial or internal malleolus on its way to the inguinal region; 4, 4, 4, trunks coming from the heel and extending along the ankle and leg; 5, 5, and 6, 6, trunks extending along the crus parallel with the calf; 7, 7, 7, 7, trunks winding round the edge of the tibia to reach the tibial or inside of the leg; 8, 8, lymphatic trunks winding round the knee to reach the inside of the leg. They are very tortuous when the knee is extended, more nearly straight when it is flexed; 9, 9, trunks curving round from the extenser side of the meros, or thigh, to reach the inguinal glands; 10, 10, 10, 10, numerous trunks winding round from the flexor side of the thigh to the inguinal glands; 11, 11, 11, trunks curving round from the extensor side of the thigh to the inguinal glands; 12, 12, trunks from the gluteal region; 13, 13, trunks from the perineal and anal region to the inguinal glands; 14, trunks from the scrotum (cf. Fig. 3269); 15, trunk from the penis; 16, the large distal gland of the ectal inguinal group, into which enter so many of the trunks of the leg; 17, another large gland at the same level; 18, large efferent trunk from 16, it follows the course of the femoral artery; 19, lymphatic trunks following the course of the femoral vein; 20, large gland receiving many of the trunks from the extensor sides of the thigh; 21, gland receiving many of the trunks from the flexor side of the thigh; 22, 22, cut end of the vena saphena magna; 23, gland in the groin to which extend many of the lymphatics from the penis (cf. Fig. 3269); 24, large corner gland receiving most of the trunks winding round the ilium from the lumbar and gluteal region; 25, 25, proximal row of glands in the fold of the groin to which extend many of the trunks from the ventral wall of the abdomen; 27, inguinal ring with the contained spermatic cord. *B*, Flexor Aspect of the Distal half of the Leg. 1, 1, Trunks from the heel and fibular side of the foot; 2, 2, two lymphatic trunks following the course of the vena saphena to the popliteal glands; 3 and 5, the two lymphatic trunks, 3 on the fibular, 5 on the tibial side of the vein; 6, vena saphena parva; 7 and 8, cut edge of the skin, and aponeurosis removed to bring the popliteal glands into view; 9, great trunk on the fibular side of the crus; it follows the contour of the calf, and by its branches furnishes nearly all the trunks on the fibular or outside of the crus; 10–12, bifurcations and branches of 9; 13, 13, trunks on the tibial side of the crus. They curve round to the inner side of the leg, and extend to the inguinal glands; 14 and 16, trunks on the fibular side of the thigh, which wind round to the extensor aspect, and then to the inguinal glands (cf. 11 and 4); 15, large trunks on the tibial or inside of the knee, on its way from the heel, crus, and thigh, to the inguinal glands; 16 and 17, trunks winding round the thigh in opposite directions to reach the inguinal glands.

paw) demonstrate vessels on the dorsum and great-toe side of the foot. Part of these trunks follow the course of the long saphenous vein, others, usually larger trunks, wind round the calf, with the short saphenous vein, to the popliteal space and enter a popliteal gland (Fig. 3281, 16). In the rabbit, branches extend to the popliteal space from both sides of the crus (Fig. 3286). From the popliteal gland the main efferent vessels in all pass between the peroneal and tibial nerves, and accompany the femoral artery and vein, freely anastomosing with the trunk along the saphenous artery. No inguinal glands are present, and the vessels extend directly to the lumbar glands (Fig. 3281, 22).

LYMPHATIC GLANDS IN THE LEG.—The most distal gland is the anterior tibial, situated on the interosseous ligament near the middle of the crus. Through it pass the ental trunks, following the anterior tibial vessels on their way to the popliteal glands. This gland is frequently absent. The popliteal glands (*glandulæ popliteæ*, Fig. 3268) are in the fat in the popliteal space. Two are near the surface and receive the lymphatics accompanying the short saphenous vein. Their efferent trunks pass to the two more deeply situated glands around the popliteal blood-vessels; through the deeper ones pass all the ental vessels of the foot and crus and part of those from the knee. The efferent vessels pass with the femoral blood-vessels to the inguinal glands.

Inguinal glands (*glandulæ lymphaticæ inguinales*, Figs. 3268 and 3269).—There are two layers of these—the ectal or subcutaneous and the ental or subaponeurotic.

The ectal inguinal glands, forming an oblong irregular four-sided figure with one border next Poupart's ligament. The afferent vessels are the ectal lymphatics of the entire leg, the subumbilical part of the body, and the external genitalia. The efferent vessels traverse the cribriform aponeurosis and enter the deep or ental inguinal glands; frequently a few trunks pass into the body cavity and join the iliac glands.

The ental inguinal glands are situated along the femoral artery and vein in the inguinal region and are usually three or four in number, although there may be six or seven. They are covered by the femoral fascia and are in intimate contact with the femoral vessels; one of them is

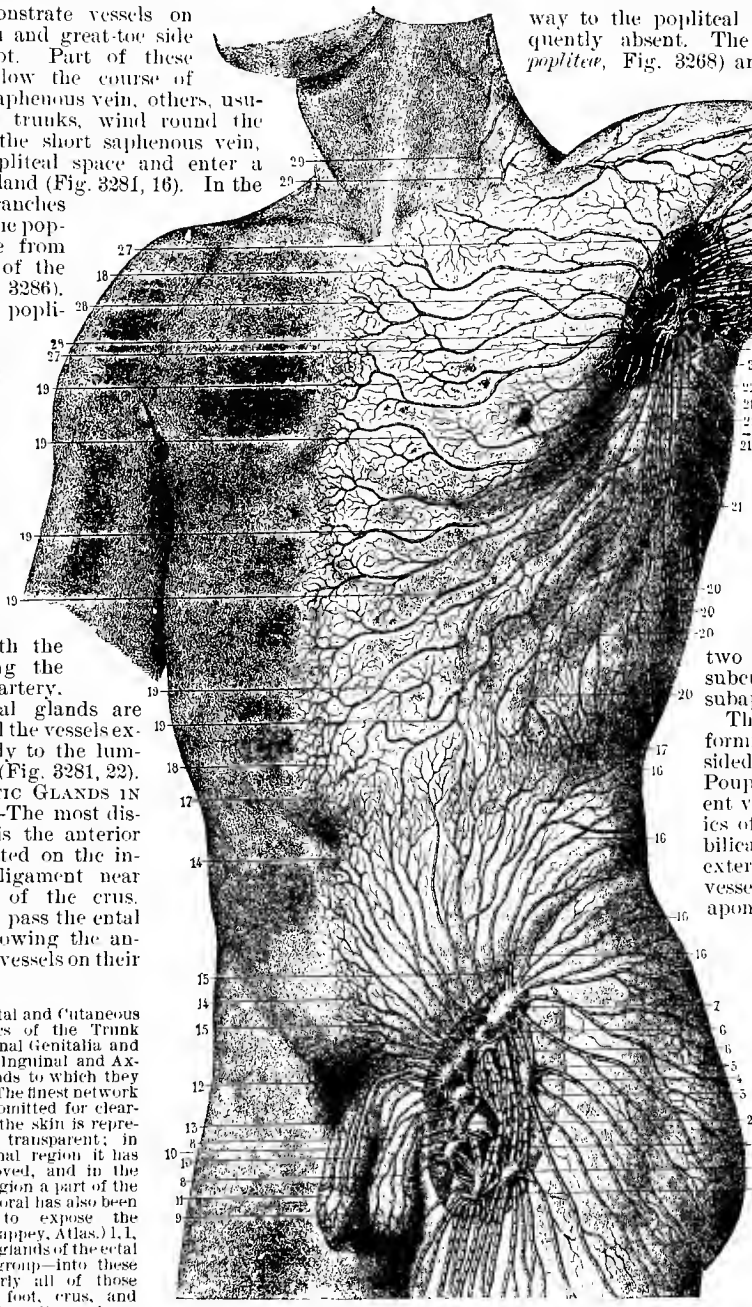


FIG. 3269.—Ectal and Cutaneous Lymphatics of the Trunk and External Genitalia and the Ectal Inguinal and Axillary Glands to which they Extend. The finest network has been omitted for clearness, and the skin is represented as transparent; in the inguinal region it has been removed, and in the axillary region a part of the great pectoral has also been removed to expose the glands. (Sappey, Atlas.) 1, 1, The distal glands of the ectal inguinal group—into these enter nearly all of those from the foot, crus, and thigh; 2, 2, median or inner glands of this group—to these come many of the trunks from the tibial or upper and inner aspect of the thigh; 3, gland near the cut end of the vena saphena magna, which receives most of the lymphatics from the median gluteal, the anal, and the perineal regions, and the scrotum; 4, a large gland forming the proximal and median corner of the ectal inguinal group—it receives the lymphatics from the penis, or, in the female, from the clitoris and part of the labia; 5, the lateral or outer gland of this group, receiving many vessels from the thigh; 6, 6, proximal glands next the abdomen—they receive the lymphatics from the ventral subumbilical region; 7, large gland forming the lateral and proximal angle of the inguinal group—to it extend the trunks from the lumbar, gluteal, and partly, also, from the abdominal region; 8, 8, lymphatics of the scrotum; 9, vessels from the prepuce; 10, 10, vessels from the integument of the penis, extending along the lateral and dorsal aspect of the organ; 11, 11, vessel making a circle around the corona of the glans—ordinarily these unite to form a single dorsal vessel, but here they remain separate and extend in a parallel course to the pubis, where each one turns to the corresponding inguinal gland; 12 and 13, the two trunks from the corona of the glans when these unite into one they bifurcate opposite the pubis and extend to the two sides as do these independent trunks; 14, 14, subumbilical lymphatics of the abdomen—they interdigitate at the ventrimeson with those from the right side of the body, just as is shown by those extending toward the axilla, so that in this intermediate area an injection might fill the vessels going in both directions, although there might be no true anastomoses of the two groups of vessels; 15, 15, subumbilical lymphatic trunks; 16, 16, trunks arising from the lumbar and gluteal region; 17, 17, area or zone where the subumbilical and thoracic lymphatics interdigitate; 18, 18, area of interdigitating vessels along the ventrimeson; 19, 19, 19, 19, 19, 19, beginnings of the trunks along the ventrimeson; 20, 20, trunks on the lateral aspect of the thorax on their way to the axilla; 21, 21, 21 trunks from the dorsal part of the thorax, on their way to the axillary glands; 22, 22, trunks from the mammary region (cf. Fig. 3274); 23, 23, trunks from the dorsal scapular region; 24, 24, trunks from the arm (cf. Fig. 3267); 25, large trunk from the ectal brachial or supra-epitrochlear glands (cf. Fig. 3267); 26, trunk accompanying the cephalic vein and terminating in the subclavian glands (cf. Fig. 3267); 27, cut through the tissues to bring into view the axillary glands; 28, axillary lymphatic glands—only part of them are exposed; 29, 29, vessels from the dorsal and lateral aspects of the neck—they terminate in the supraclavicular glands.

found almost constantly in the mouth of the inner femoral or crural ring, which, according to Henle, it assists in closing. The afferent vessels of this group are derived from the ental lymphatics of the foot, crus, and thigh (in part); the efferent trunks from the popliteal and most of those from the ectal inguinal glands.

A part of the efferent vessels traverse the abdominal wall with the femoral artery, but most of them accompany the femoral vein through the crural canal. They join the iliac glands, sending a few branches, however, to the hypogastric glands.

In the larger domestic animals (horse and ox) the glands of the leg are about as numerous as in man, but with the cat, dog, and rabbit they are represented only by the popliteal gland, the inguinal glands being absent, unless the gland on the external epigastric vessels may represent the ectal inguinal glands. As the iliac glands are also absent, vessels may pass from the foot (*i.e.*, those accompanying the saphenous artery) directly to the lumbar glands (Figs. 3281, 3284, and 3286).

Lymphatics of the Abdomen and External Genitalia.—The ectal lymphatics of the abdomen have three quite sharply defined areas of origin, and from these the vessels extend in opposite directions. The areas are the dorsimeson, the ventrimeson, and a somewhat irregular zone surrounding the body at the level of the umbilicus (Fig. 3269). The vessels cross these boundaries and interdigitate in a complex manner; frequently a puncture made in the boundary will give rise to an injection in both directions, although injections made at either side would inject only the corresponding side. In the lower animals especially investigated for this—cat and opossum—the communication from side to side is more intimate, an injection of one side often filling that of the other. This is especially marked opposite the pubis of the opossum, where there is constantly a large transverse lymphatic, recalling the transverse vessels between the jugular veins.

As seen in Fig. 3269, the lymphatics of the umbilical region of the body extend in the most direct manner on the abdomen to the inguinal or the axillary glands. Those from the lumbar and gluteal regions extend around in great curves, often following the crest of the ilium, to the lateral inguinal glands. Others from the gluteal region curve round the nates to the perineal and anal regions, finally to join the perineal and anal vessels and extend with them to the median glands of the ectal inguinal group.

The lymphatic network around the anal opening is very dense and is continuous with the lymphatics of the rectum. Those of the perineum are less dense. From both these regions the vessels wind round the thigh to the median or inner of the ectal inguinal glands. In the female the number of the trunks from the perineum is reduced apparently in direct proportion to the reduction in area of the region. The lymphatics of the external genitalia of the male are naturally divisible into those of the scrotum and the penis. The vessels of the scrotum are very numerous, perhaps more so than in any other equal area of integument in the body. As in the trunk, the meson—here indicated by the raphe—forms a natural dividing line for the two sides. The vessels extend in great curves, partly to the pubis and partly on the thigh, to enter the median row of ectal inguinal lymphatic glands; those on the thigh communicating with the vessels from the perineum, and those of the pubis with the cutaneous vessels of the penis. The vessels of the integument of the penis, commencing on both surfaces of the prepuce and from the line of the urethra, wind round the two sides to the so called dorsum of the organ when they extend toward the pubis, and curve laterally toward the two sides to enter the large gland forming the corner of the ectal group (Fig. 3269, 4). The lymphatics of the glans penis are exceedingly numerous, and in several superimposed layers of networks. The collecting trunks converge toward the frænum preputii, where they are joined by the trunks from the urethra.

The urethral lymphatics begin at the prostate, anastomose with the prostatic lymphatics, with the network of the ejaculatory canals, and through them with the *vesiculæ seminales*. They extend to the *meatus urinarius*, forming a hollow cylindrical network of large, densely packed lymphatics (Fig. 3270), which reaches its greatest development opposite the fossa navicularis. Opposite the frænum two or three trunks penetrate the urethral wall and join the trunks from the glans, then penetrate the substance of the penis and reach the dorsal aspect of the *corpus spongiosum*, where the trunks of the two sides usually unite into one, which follows the course of the deep blood-vessels to the pubis, when it again divides, sending a branch to each side, finally to terminate in the large median gland of the ectal inguinal group (Fig. 3269). According to most authors, the urethral and glandular lymphatics of the penis follow the internal pudic blood-vessels into the abdomen and enter the hypogastric glands. But Sappey is very definite, both in his atlas and anatomy, in stating that they enter the large gland forming the corner of the ectal group.[1]

The lymphatics of the external genitalia of the female very closely resemble those of the male in their arrangement and termination. The collecting trunks from the clitoris and the surrounding parts extend nearly directly to the pubis, where they curve to the right and left, and terminate in the large median gland forming the corner of the ectal inguinal group, and, according to Kranse,[6] they also communicate with the lymphatics of the round ligament of the uterus.

The lymphatics of the female urethra are less abundant than in the male. The trunks from the urethra, meatus urinarius, labia, and the external or inferior fourth of the vagina extend laterally to reach the vulvocrural fold, in which they wind around the thigh, with a few small trunks from the perineum to the median of the ectal inguinal glands, only a few reaching the large corner gland to which so many from the male genitalia extend.

The ental lymphatics of the abdominal wall and the lumbar part of the trunk follow the deep blood-vessels; part, therefore, extend to the sternal and axillary glands; part, with the deep epigastric vessels, to the iliac glands; part, with the lumbar and ileo-lumbar vessels, to the lumbar glands. Still others follow the circumflex iliac vessels, often traversing one or more glands along the crest of the ilium before finally entering the iliac glands.

With the dog, cat, and rabbit, the lymphatics of the abdominal wall and the external genitalia are as in man, except that the tendency to form anastomoses across the meson is more marked, and that there is constantly present along the external epigastric vessels, about opposite the brim of the pelvis, a considerable gland. To this gland pass the ectal abdominal lymphatics, also part of those from the elongated mam-

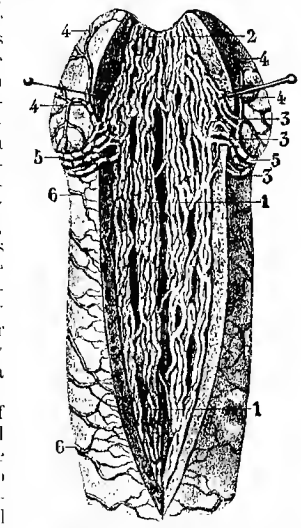


Fig. 3270.—Human Penis, opened Longitudinally to show the Urethral Lymphatics. (Sappey, Atlas.) 1, 1, The very abundant longitudinal network of vessels in the urethral mucosa; 2, continuity of the urethral lymphatics with those of the glans at the meatus urinarius; 3, 3, 3, trunks traversing the urethral wall opposite the frænum and joining those of the glans; 4, 4, 4, 4, trunks from the periphery of the glans joining those from the urethra; 5, 5, large trunks formed by the union of the urethral lymphatics and those from the glans; they penetrate the substance of the penis and follow the deep blood-vessels to the pubis, whence, according to Sappey, they extend to the inguinal, but, according to many authors, to the hypogastric lymphatic glands; 6, 6, lymphatics of the integument of the penis.

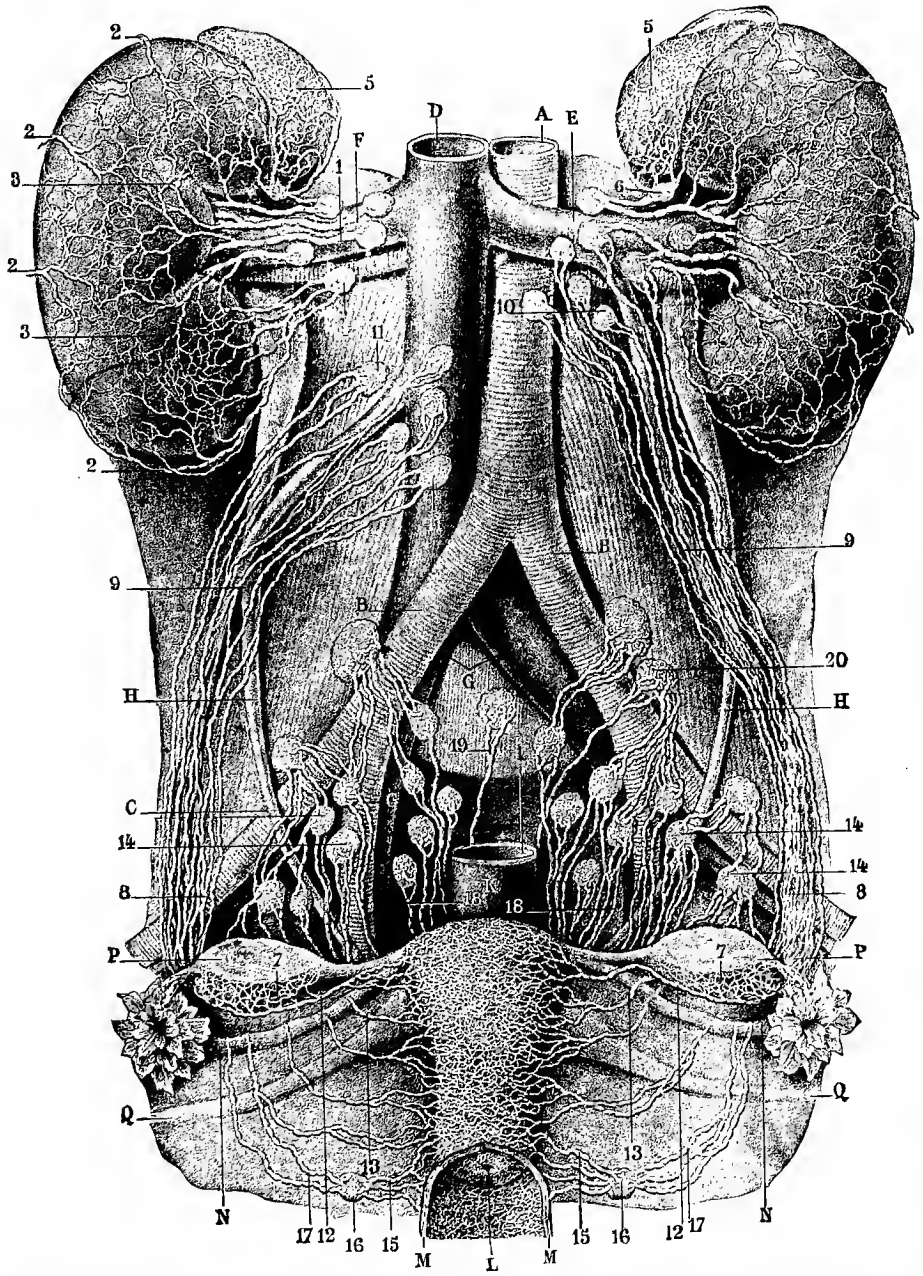


FIG. 3271.—Lymphatics of the Kidneys, Adrenals, and Internal Genitalia of a Girl of Thirteen Years. (Sappey, Atlas.) *A*, abdominal aorta; *B*, *B*, common iliac arteries; *C*, *C*, the external and internal iliac arteries formed by the bifurcation of the common iliac; *D*, post-cava; *E* and *F*, left and right renal veins; *G*, common iliac veins; *H*, *H*, ureters; *I*, cut end of the rectum; *K*, uterus; *L*, neck of the uterus (the line points to the os uteri); *M*, *M*, cut edge of the vaginal wall; *N*, *N*, Fallopian tubes; *P*, *P*, ovaries; *Q*, *Q*, round ligaments. 1, ental lymphatic trunks from the kidney and the glands of the lumbar plexus into which they enter; 2, 2, 2, 2, surface or ectal lymphatics of the kidney which extend first to the lateral aspect, and then converge around the ends of the kidney to the hilus, where they join the ental lymphatics, or enter the same group of glands independently; 3, 3, vessels on the broad surface of the kidney converging directly to the hilus to join the ental lymphatics; 4, gland receiving the ectal lymphatics of the caudal third of the kidney on the right; 5, lymphatic network of the adrenal, it freely anastomoses with that of the kidney, and many of the trunks enter a gland situated in the angle between the adrenal and the kidney on the mesal aspect; 6, lymphatic gland through which pass many of the lymphatics of the adrenal, and some from the kidney; 7, 7, subovarian lymphatic network; it is joined by a large trunk from the base of the uterus, and together they follow the utero-ovarian vein to the lumbar lymphatic plexus; 8 and 9, trunks from the subovarian network to lumbar glands at the termination of the ovarian vein; 10, 10, lumbar glands receiving the left ovarian trunks; part of these are common to the lymphatics of the kidney; 11, 11, glands receiving those from the right; 12, 12, trunks from the base of the uterus to the subovarian network; 13, 13, trunks from the borders and the ventral face of the uterus, they extend to 14, the iliac group of glands; 15, vessels arising from the neck of the uterus, the uterine mucosa, the vaginal part of the uterus, and from about three-fourths of the extent of the vagina; they extend to 16, the utero-vaginal gland; 17, 17, efferent vessels from the utero-vaginal gland to the iliac glands; 18, 18, vessels from the dorsal part of the neck of the uterus, extending to the hypogastric lymphatic glands; 19, trunk from the neck of the uterus to a gland on the body of the fifth lumbar vertebra; its presence is exceptional; 20, iliac gland receiving an unusual trunk from the neck of the uterus.

mary glands and from the external genitalia. There is another gland along the external epigastric blood-vessels about opposite the umbilicus, in the cat at least. After traversing these glands the efferent vessels either join or accompany the femoral lymphatics to the lumbar glands. In the cat they penetrate the abdominal wall with the epigastric artery, and extend, in part, to the hypogastric, and in part to the lumbar glands (Fig. 3281, 14, 21). The epigastric glands may represent the ectal inguinal glands of man. In the rabbit there is also constantly present a gland on the iliolumbar vessels, next the abdominal wall, and along the edges of the sartorius muscle; the efferent vessels pass to the lumbar glands (see 22 of Fig. 3286).

LYMPHATICS OF THE PELVIC AND ABDOMINAL VISCERA.—*Internal genitals of the male — testicle, spermiduct, vesiculæ seminales,* and *prostate.* —Probably no organ in the masculine body is more richly supplied with lymphatics than the testicle. Those of the albuginea are sometimes described as the ectal lymphatics of the testis.

They are only moderately numerous, and extend upon the spermiduct to join those from the testicle proper. Those of the testicle proper follow the seminal tubules to the epididymis, and joining those of the epididymis extend with the spermatic cord through the inguinal canal. After reaching the body cavity they

follow the blood-vessels, and finally terminate in the lumbar glands near the end of the spermatic vein.

The lymphatics of the testis of a mature animal are exceedingly easy to inject by the puncture method, and the collecting trunks accompanying the spermatic vein are so prominent, straight, and well supplied with valves that they are among the most striking of the lymphatic trunks in the body.

The lymphatics of the spermiduct are abundant at the ends, but very few along the middle part. Those from the testicular half follow the lymphatics of the testis, while those from the other half join the lymphatics of the vesiculæ seminales. The lymphatics of vesiculæ seminales form a close network, which was first described by Hewson; they unite into two principal trunks. Those next the spermiduct join the lymphatics of the latter, and together they enter one of the iliac glands. The other trunk passes between the prostate and vesiculæ seminales, so as to join an iliac gland. The lymphatics of the prostate were discovered and described by Sappey in 1854, who found them abundant, and with two collecting trunks on each side. One of the trunks passes quite directly to one of the hypogastric glands, while the other extends upon the walls of the urocyst, or urinary bladder, and then curves to the side to enter a hypogastric gland. The trunks extending upon the urocyst were mistaken by Mascagni and Cruikshank for the lymphatics from the bladder itself.

Internal Female Genitalia—Vagina, Uterus, Fallopian Tubes, and Ovaries.—As described above, the external or inferior fourth of the vagina sends its lymphatics to the ectal inguinal glands; from the remaining three-fourths the collecting trunks extend toward the uterus, penetrate the walls of the vagina, and traverse the utero-vaginal lymphatic gland on the way to the hypogastric glands. Up to the present, no lymphatics have been demonstrated in the muscular wall of the vagina in the human being, but their presence has been shown in that of the large domestic animals.

The uterine lymphatics are naturally divided into those of the mucosa and those of the muscularis. Those of the mucosa are difficult or impossible to demonstrate in a gravid uterus, and often so in a non-gravid adult uterus, and Sappey states that he never succeeded in demonstrating them in the uterine mucosa of any of the lower animals. It is only in girls before puberty that these lymphatics are demonstrable by the ordinary methods. No doubt they exist in the adult woman, and also in the uterine mucosa of the lower animals, but they have not been satisfactorily demonstrated. When demonstrated in a child they showed a delicate network whose collecting trunks traverse the walls of the neck of the uterus and enter the utero-vaginal lymphatic glands (15 and 16, of Fig. 3271). At the os uteri they are continuous with those on the vaginal part of the uterus and the vaginal mucosa.

The lymphatics of the uterine walls are numerous and easily demonstrated in most animals. The collecting trunks extend laterally in the broad ligament on each side to three different groups of glands; those from the summit follow the Fallopian tubes out to the ovary, where they join the ovarian network, and accompany the collecting trunks of the ovary to the lumbar glands around the termination of the ovarian veins (Fig. 3271). Those from the body of the organ extend across the broad ligament, curve round the Fallopian tubes, and enter the iliac glands; while those from the cervical region extend with those from the utero-vaginal glands to the hypogastric plexus.

Lymphatics have been demonstrated only on the uterine and ovarian ends of the Fallopian tubes. But it is probable that they are present throughout the whole extent. The collecting trunks accompany the ovarian lymphatics.

The lymphatics of the ovary, like those of the testis, are in prodigious numbers, and are very easily injected. The collecting trunks are very long and straight and accompany the ovarian vein, and consequently those on the left are opposite the hilus of the kidney (Fig. 3271).

In the lower animals, so far as has been investigated, the lymphatics of the internal genitalia agree in all essential particulars with those of the human being. In the dog, cat, and rabbit, while the ovarian and testicular lymphatics follow the same general course, they almost always enter the lumbar glands, and therefore do not follow the spermatic or ovarian veins to their termination (Fig. 3281, 21, 22).

Urinary Organs and Adrenal.—Up to the present time all efforts to demonstrate lymphatics in the mucosa of the urocyst or urinary bladder have failed both with men and with animals, but the muscular coat has been shown to be plentifully supplied. The vessels form a wide-meshed network at the summit and on the body. This network unites into one or more trunks on each side, and the trunks extend nearly or quite to the neck when they turn aside and enter the hypogastric lymphatic glands. The trunks described by Cruikshank and Mascagni as urocystic lymphatics were really from the prostate. Sappey succeeded only once in injecting them in man, but almost constantly in the dog and rabbit.

The muscularis of the ureters has been shown to possess lymphatics in the horse, but all attempts to demonstrate them in the mucosa have failed. Although not demonstrated in man they are presumably present.

The lymphatics of the kidney form an ectal network over the surface and an ental network in the substance of the organ. The trunks were first seen in 1532 by Massa, but first described carefully by Nuck in 1590. Those of the surface form a wide-meshed network, the collecting trunks of which extend in part directly toward the hilus of the kidney and join the ental lymphatics and part extend toward the convex border and then wind round the ends to the hilus. Next the adrenal the lymphatics of the two organs are closely connected. The ental lymphatics follow the blood-vessels and terminate in a group of the lumbar glands situated on the renal vessels.

Although the blood-vessels of the adrenal have been long known, the lymphatics were not so early discovered. It is now known that the lymphatics are as abundant as the blood-vessels, extending throughout the substance as well as upon the surface. The collecting trunks, many of them join those of the kidney, and all extend to a gland near the junction of the adrenal and kidney (5, 6, of Fig. 3271).

Lymphatics of the Intestine and Stomach.—Throughout the entire alimentary canal, it has been shown that where a distinct muscular coat exists the lymphatics form two layers or sets, one in the mucosa, including the submucosa, and one in the muscularis. In those parts supported by duplicatures of serosa (mesenteries) the finer network of the mucosa proper extends to a coarse and characteristic network in the submucosa (Fig. 3298), and finally the collecting trunks penetrate the wall at the attached edge and join the lymphatics of the muscularis. The lymphatics of the muscularis are throughout its entire thickness, but soon become subserous and wind round to the attached edge, and with those from the mucosa extend between the layers of the supporting membrane mostly in company with blood-vessels to lymphatic glands, which are also situated between the serosal walls (Fig. 3272, 2, 3, 4; Plate XLIV.).

The intestinal lymphatics at the anus are directly continuous with those of the skin. The trunks from the muscularis and mucosa of the rectum extend between the folds of the mesorectum, often traversing minute glands in their course, and then enter the sacral lymphatic glands and ultimately go to the lumbar glands on their way to the chylocyst. The lymphatics of the main part of the *colon descendens* pass to the lumbar lymphatic plexus. Those of the *cæcum, colon ascendens et transversum*, also part of the *colon descendens* pass through one or more of the numerous mesocolic glands and then enter the mesenteric glands and mingle with the lacteals from

the small intestine, and with these go through the *truncus intestinalis* to the chylocyst.

Lacteals.—The lymphatics of the small intestine are usually called lacteals or chyle vessels, from the fact that during digestion they have a cloudy or milky appearance owing to the contained chyle (Figs. 3292, 3293, 3294, 3300).

As the small intestine has two planes of lymphatics like the rest of the alimentary canal, it is really only those of the mucosa which absorb and convey the chyle, and which, therefore, should properly be denominated lacteals, as those from the muscularis always convey lymph only. A further and finer distinction still has been made by Sappey,[1] who holds that the vessels of the intestinal villi are the only ones which absorb the chyle, and they do nothing else, so that they alone are the true lacteals, and that the other lymph vessels of the mucosa and submucosa, including those from the Peyerian patches and other lymphoid tissue, should be considered simply lymphatics, as they take no part in the absorption of the chyle. The submucosal network simply receives the chyle poured into it by the lacteals of the villi. As stated above, this is not the common view. It is ordinarily believed that the lacteals contain lymph like other lymphatics, except during digestion. It is also common to call all the vessels from the small intestine lacteal vessels, without regard to their origin from the muscularis or the mucosa. Whatever the origin, all the vessels unite at the attached border and extend to the nearest gland, where their contents are mixed, so that usually all the collecting trunks in the mesentery appear milky and are called lacteals or chyle vessels, although some of them might really have come from the large intestine. In man there are usually several tiers of mesenteric glands through which the chyle passes before finally emptying into the large trunk along the superior mesenteric artery. This trunk, which also receives the efferent vessels of the cœliac and mesocolic glands (*truncus lymphaticus intestinalis*), is either single or multiple, and forms one of the most important constituents of the chylocyst (Figs. 3281–3287).

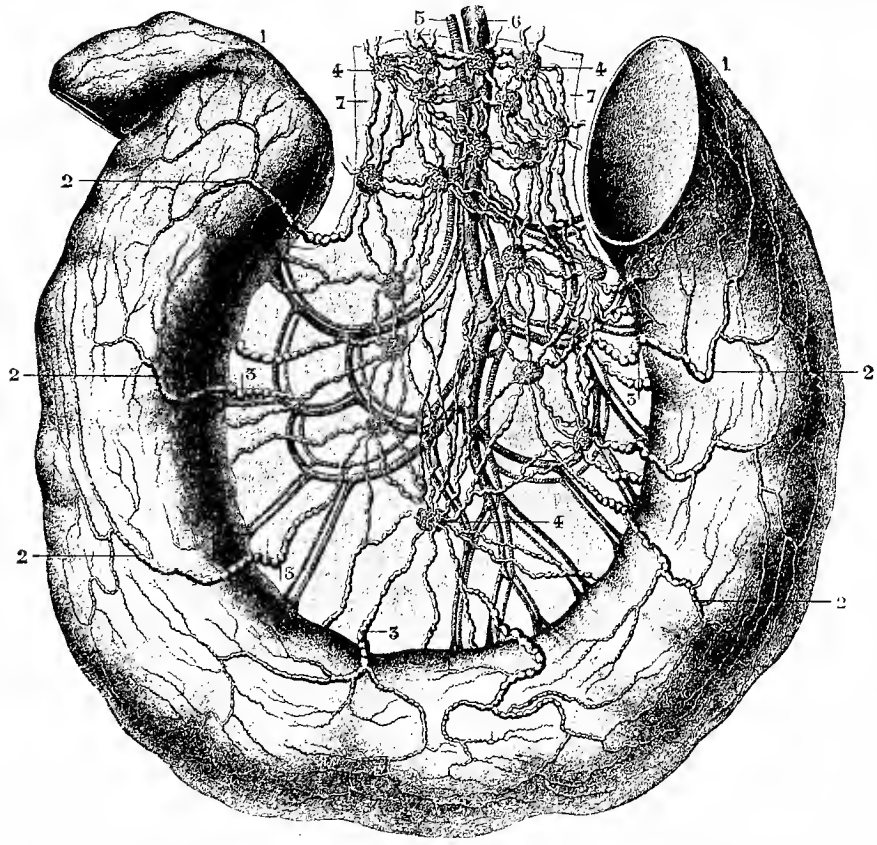


FIG. 3272.—Loop of the Small Intestine of Man, to show the Mesenteric Glands and Blood-vessels, and the Lymphatics from the Muscularis. (Sappey, Atlas.) 1, 1, The ends of the loop of intestine; 2, 2, 2, 2, 2, 2, lymphatic vessels arising in the muscular layer; 3, 3, 3, swellings or enlargements in these vessels near the mesenteric edge of the intestine; 4, 4, 4, mesenteric glands along the course of the lymphatics; 5, branch of the superior mesenteric artery; 6, mesenteric vein; 7, the mesentery.

Stomach.—The lymphatics of the stomach are continuous with those of the œsophagus and duodenum. Those of the muscularis form a most beautiful network throughout the entire thickness of the coat; the collecting trunklets penetrate the tissue and become subserous, and from an intermediate area on both faces extend to the nearest of the chain of lymphatic glands, extending almost around both curvatures; those in the lesser curvature being known as the *glandulæ lymphaticæ gastro-epiploicæ superiores*, and those around the great curvature as the *glandulæ lymphaticæ gastro-epiploicæ inferiores* (Plate XLIII.). The lymphatics of the gastric mucosa form a remarkable network throughout the entire thickness of the coat, being very fine in the mucosa proper and coarser in the submucosa. The collecting vessels penetrate the muscularis along the curvatures, join those of the muscularis, extend to the same glands, and finally to the intestinal lymphatic trunk (Plate XLIV.).

Pancreas.—The lymphatics of this organ are difficult to demonstrate, but when well injected are found to form a fine network around the tubules, and the collecting trunks emerge quite directly to the surface, and form upon the surface a round-meshed, rather coarse network around the lobules. From this network vessels extend in three directions—part of them going to the tail or splenic end of the pancreas to join the glands at the hilus of the spleen, part to the gastric edge of the pancreas to enter some of the numerous glands along the course of the splenic vessels, and still others extend toward the duodenum to enter a large gland which also receives part of the lymphatics of the duodenum. The lymph finally reaches the intestinal trunk after traversing one or more of the cœliac glands. No lymphatics have been demonstrated in the pancreatic ducts.

Spleen.—The lymphatics of the spleen are in enormous numbers. Their origin seems to be from the lymph follicles so abundant throughout the organ. According to Sappey, the usual division of the lymphatics into a superficial and deep set does not hold with man, in whom

any vessels on the surface quickly enter the substance of the organ and accompany the ental blood-vessels. With the horse, ox, and pig, however, there is a true ectal network extending over the entire surface. The collecting trunks pass to the hilus of the organ and terminate in the numerous glands there situated. The efferent trunks from these glands pass to the cœliac glands and the intestinal lymphatic trunk, or some may enter the chylocyst directly.

Liver.—The lymphatics of the liver were very early seen, and the efferent trunks *from* the hilus were, for a long time, supposed to be the continuation of the lacteals *to* the liver. It has been found that the lymphatic system of the liver is quite as remarkable as the blood supply. In general there are both ectal and ental lymphatic vessels, and the ducts and gall bladder possess a rich supply. The collecting trunks form three great groups and take three main courses, following the portal or extend to the glands around the postcava as it enters the thorax. On both sides of the suspensory ligament the trunks collect in great numbers, and extend between the folds of the suspensory ligament to the diaphragm, which they penetrate, and enter two or three glands whose efferents join the sternal plexus (14 of Fig. 3275, and 13 of Fig. 3276). Still farther to the left, a group passes round to the postcava as it enters the thorax on the right, still others penetrate the triangular ligament and enter the glands around the œsophagus. Many of the apparently superficial lymphatics of this lobe penetrate the substance of the liver and join the ental lymphatics as with the right lobe. In fact, in most animals this is the normal condition, and a true ectal set of lymphatics is not present. On the concave surface of the liver, many of the surface lymphatics penetrate the liver substance and join the ental lymphatics, but the greater number join the glands in the hilus and thus mingle with

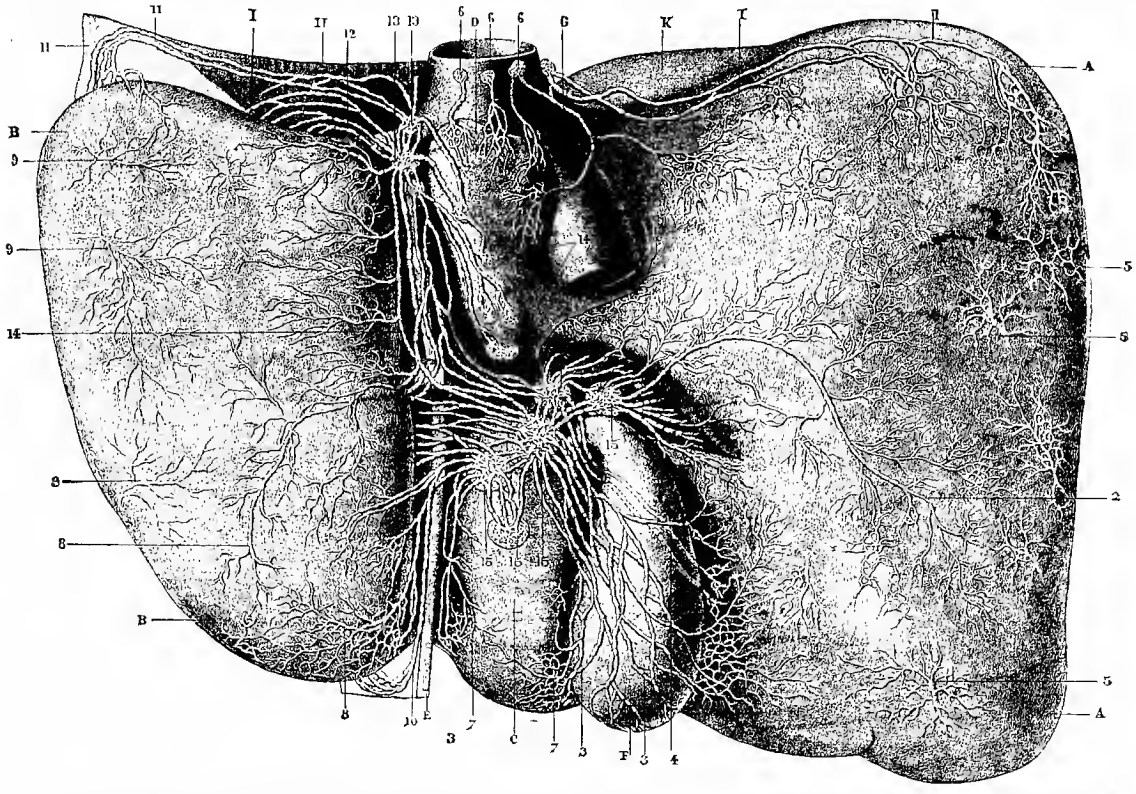


FIG. 3273.—Lymphatics and Lymphatic Glands on the Concave Aspect of the Liver of Man. (Sappey, Atlas.) *A*, *A*, Right lobe of the liver; *B*, *B*, left lobe; *C*, quadrate lobe; *D*, Spigelian lobe; *E*, round ligament or remnant of umbilical vein; *F*, cholecyst or gall bladder; *G*, postcava receiving the hepatic veins just as it traverses the diaphragm; *H*, left triangular ligament of the liver; *I*, diaphragm; *K*, the most projecting part of the convex surface of the liver. 1, 1, Two trunks near the cephalic edge of the right lobe extending to the glands on the postcava just within the thorax; 2, single trunk from the middle of the right lobe to the lymphatic glands in the hilus of the liver by the neck of the cholecyst; 3, 3, trunks upon and at the border of the cholecyst to the glands in the hilus; 4, two vessels having the same origin and termination, but covered by the cholecyst; their course is indicated by the dotted lines; 5, 5, trunks arising on the surface of the right lobe, but penetrating the substance of the liver to accompany the ental vessels; all the vessels from the surface take this course in most animals; 6, 6 6, trunks from the Spigelian lobe, and the glands around the postcava receiving them; 7, 7, vessels belonging to the quadrate lobe; 8, 8, principal trunks of the left lobe; 9, 9, vessels arising on the surface, but soon entering the liver to join the deep lymphatics like 5 of the right lobe; 10, trunks from the convex surface of the liver following the round ligament and finally entering the glands at the hilus; 11, 11, 12, several trunks from the convex surface of the left lobe, winding over to the concave surface and entering glands in the fissure of the ductus venosus; 13, 13, lymphatic glands in the fissure of the ductus venosus, their efferent vessels extend to the glands in the hilus; 14, glands corresponding to the terminal end of the œsophagus; 15, 15, lymphatic glands receiving the lymphatics from most of the concave surface of the liver and the ental lymphatics following the portal vein.

vessels to the hilus, the hepatic vessels to the postcava, and the supensory ligament to the diaphragm.

The ectal or superficial lymphatics of the convex surface extend in four directions, according to their position. Most of those near the caudal or inferior border penetrate the surface and join the ental lymphatics. In the right cephalic (superior) part, they wind round the border and join the glands at the head of the pancreas, the ental lymphatics (Fig. 3273). The ental or deep lymphatics, according to Sappey, are divided into two distinct, although anastomosing sets, one set following the portal vessels and bile-ducts, the other the hepatic vessels. Those following the hepatic vessels enter the thorax, traversing some glands on the postcava, and mingling with the ectal lymphatics, follow the pillars of the diaphragm to join the thoracic duct. The lymphat-

ics following the portal veins reach the hilus of the liver, and traverse one or more of the glands there situated (Fig. 3273). From these glands in the hilus, branches extend to the glands in the lesser curvature of the stomach, and to those on the splenic vessels; but finally all pass to the cœliac glands, and then some branches may enter the chylocyst independently, but most of them join the intestinal trunk.

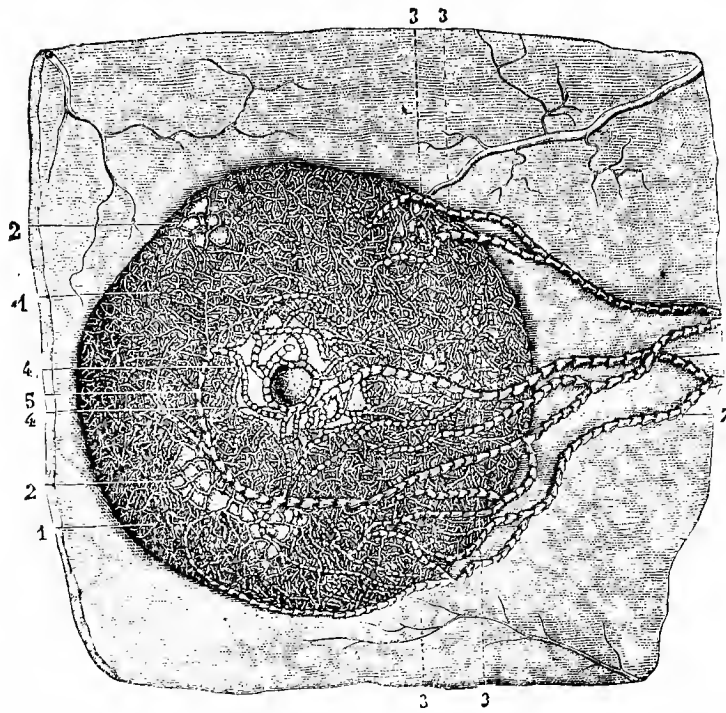


FIG. 3274.—Left Mammary Gland of a Woman during Lactation. The skin and adipose tissue have been removed to bring the lymphatics plainly into view. At three of the corners of the figure blood-vessels are represented. (Sappey, Atlas and Anat.) 1, 1, Network of lymphatics so dense that they make almost a continuous layer. The entire gland is filled throughout in this way; 2, 2, truncules surrounding the lobules, the finer network being omitted; 3, 3, 3, large trunks at the border of the gland; 4, 4, network of large vessels around the nipple; they originate in the depth of the mamma; 5, 5, great trunk arising at the mesal side of the nipple, and extending across the gland and pectoral region to the axillary lymphatic glands; 6, large trunk from the lateral aspect of the nipple extending directly toward the axilla; 7, large trunk from the caudal (inferior) border of the mamma, and uniting with the preceding on its way to the axilla; 8, 8, the two great trunks from the mammary gland going to terminate in the axillary lymphatic glands.

Lymphatic Glands, Plexuses, and Trunks of the Abdominal and Pelvic Cavities.—The glands in the abdominal and pelvic cavities form a continuous network from the inguinal glands to those in the œsophageal opening; they also extend out on the great vessels of the viscera. Although there are no sharply defined limits and limited grouping of the two hundred to four hundred glands in this part of the body, groups have been made as in the neck for convenience. Following Krause, the following groups may be recognized, commencing with the iliac region: (1) Iliac; (2) hypogastric; (3) sacral; (4) lumbar; (5) mesenteric, including those of the mesocolon; (6) cœliac. Each of these groups of glands with the connecting vessels is also called a plexus. As the efferent vessels of all these groups unite to form the *chylocyst* and thoracic duct by three main trunks, these also have received names: (1, 2) The two lumbar trunks (a *truncus lymphaticus lumbalis* of each side) from the iliac, hypogastric, sacral, and lumbar plexuses, and (3) a single trunk (*truncus lymphaticus intestinalis*) from the mesenteric and cœliac lymphatic plexuses. As was remarked in discussing the cervical glands, different authors may assign a collecting trunk from an organ to different groups of glands, although the same gland is meant. As the division into groups is artificial, and the glands vary considerably in position and in different individuals, even in number, this confusion is probably inevitable.

The iliac lymphatic glands and plexus (*glandulæ iliacæ, s. iliacæ, s. anteriores; plexus lymphaticus iliacus, s. iliacus externus, s. anterior*) form a chain along the external and common iliac blood-vessels. At the crural ring this plexus is continuous with the inguinal plexus. The afferent vessels are from the inguinal plexus, those accompanying the internal epigastric and circumflex iliac blood-vessels, those from the vesiculæ seminales and the body of the uterus (those from the last two sources are often said to extend to the hypogastric plexus). This plexus is connected with the hypogastric and sacral by several communicating branches, but the main efferent trunks pass to the lumbar plexus.

Hypogastric Glands and Plexus (*glandulæ lymphaticæ hypogastricæ, s. iliacæ internæ, s. pelvinæ; plexus hypogastricus, s. iliacus internus, s. pelvinus*). These are on the sides of the pelvis, around the hypogastric and internal iliac blood-vessels. The afferent lymphatics are from the gluteal, sciatic, and obturator vessels, part of the spermiduct, the prostate, urocyst, most of the vagina, the uterine mucosa, and neck of the uterus. According to most authors, the ental lymphatics of the external genitalia in both sexes pass to these glands. Sometimes also part of the inguinal efferents pass to this group. This plexus is closely connected with the iliac and sacral, but its principal efferent trunks pass to the lumbar plexus.

Sacral Glands and Plexus (*glandulæ lymphaticæ sacrales; plexus lymphaticus sacralis*). This group of glands is between the folds of the mesorectum next the sacrum. The afferent vessels come from a part of the pelvic wall, and the vertebral canal, and from the rectum. Like the other pelvic plexuses it is connected with all the others, but its efferent trunks pass to the lumbar plexus.

The Lumbar Glands and Plexus (*glandulæ lymphaticæ lumbales, s. lumbares; plexus lymphaticus lumbalis*). The lumbar glands form three irregular rows, one mesal and two lateral, extending along the great blood-vessels from the bifurcation of the aorta nearly to the origin of the superior mesenteric artery. Its afferent vessels are the efferent trunks from the iliac, hypogastric, and sacral plexuses, lymphatics accompanying the ilio-lumbar and part of the lumbar blood-vessels, those from the testis, spermiduct in part, ovary, summit of uterus, Fallopian tubes, kidney, adrenal, and most of the colon descendens. It is also connected by a greater or less number of communicating branches with the cœliac plexus. Its efferent vessels unite to form two principal trunks, a right and left lumbar lymphatic trunk (*truncus lymphaticus lumbalis*), which with the intestinal trunk form the *chylocyst*, the enlarged beginning of the thoracic duct.

Cœliac Glands and Plexus (*glandulæ lymphaticæ cœliacæ; plexus lymphaticus cœliacus*). The cœliac plexus is situated along the cœliac vessels, the portal vein and the beginning of the superior mesenteric artery on the dorsal side of the pancreas, duodenum, and pylorus. This group was formerly reckoned as part of the lumbar plexus. The efferent lymphatics come from the stomach,

part of the œsophagus and duodenum, part of the liver, the pancreas, and spleen. The efferent vessels join the intestinal trunk, or sometimes one or more branches pass directly to the chylocyst.

Mesenteric Glands and Plexus (*glandulæ mesentericæ, s. mesaraicæ; plexus lymphaticus mesentericus, s. mesaraicus*). The mesenteric glands and plexus (one hundred to two hundred) lie along the blood-vessels between the folds of the mesentery and the meso-colon. They are usually in three irregular tiers, one tier being near the intestine, one near the middle, and one near the root of the mesentery. The afferent vessels are from the small intestine, except part of the duodenum, and the large intestine to the sigmoid flexure. The efferent vessels receive the efferent trunks from the cœliac plexus, and then terminate in the chylocyst as the intestinal trunk (*truncus lymphaticus intestinalis*).

As will be seen by a glance at Figs. 3281–3286, the lymphatics and the glands in the abdominal cavity of the dog, cat, and rabbit are essentially as in man, but there is a great concentration of the glands, so that the groups are well defined. No sacral glands were certainly found in any of them.*

Lymphatics of the Thorax.—The thoracic lymphatics are divisible into three fairly distinct, although communicating, groups: (1) Those of the skin and other surface structures; (2) the ental lymphatics of the thoracic walls, including the diaphragm; (3) the lymphatics of the thoracic viscera—heart, lungs, trachea, and œsophagus.

The ectal lymphatics, like those of the abdomen, are quite sharply divided into those of the right and those of the left side, although on both the dorsi- and ventri-meson the vessels interdigitate.

The beginning of many of the subcutaneous trunks of the thorax is likewise from an oblique zone surrounding the body at about the level of the umbilicus (Fig. 3269), and there is a somewhat similar, although less clearly defined, limiting zone between the neck and thorax. The collecting trunks extend in the most direct manner to the axillary lymphatic glands (Fig. 3269). Part of those, however, in the subclavicular and adjoining pectoral regions pass to the supraclavicular glands. This is supposed to explain the involvement of these glands in some cases of cancer of the breast.[1]

Belonging to this ectal group are the lymphatics of the mammary gland. In the male they are but little more developed than the surrounding integument; but in the female, especially in preparation for and during lactation, they are present in enormous numbers, and their size is also greatly increased. Those of the mammary integument are especially numerous in the areola, but it is in the glandular substance itself that they reach their highest development. From the substance of the gland they reach the surface in four places, and extend as four principal trunks toward the axilla, but most often unite to form two large trunks before entering the axillary glands. Most authors assign part of the lymphatics of the breast to the internal mammary or sternal plexus, but Sappey states that the course is as described above.

Besides the lymphatics from the mammary glands, many of those from the ectal muscles pass to the axillary glands. These trunks pass along the great pectoral muscles and the vasa thoracica longa, and usually traverse a few small glands (pectoral glands) in their course.

The lymphatics of the diaphragm were discovered by Rudbeck, and fully described by Nuck. They are among the most easily demonstrated of any in the body, and from the thinness of the diaphragm and the clearness with which the lymphatics may be fol-

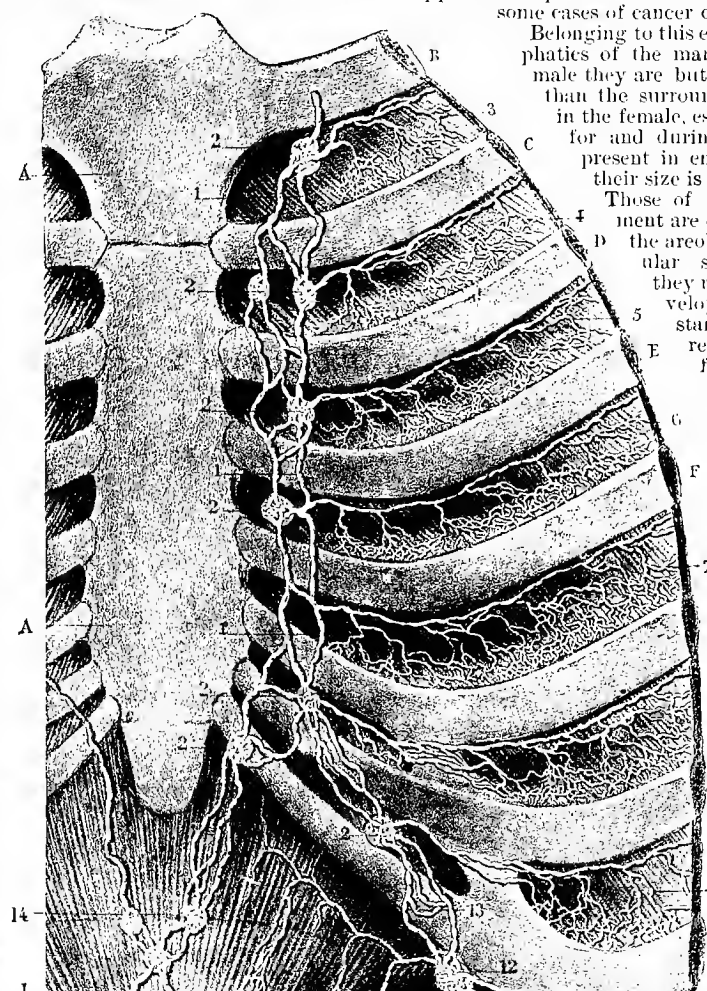


Fig. 3275.—The Ental or Pleural Aspect of the Sternum, Parts of the Ribs and the Diaphragm, to show the Sternal Plexus. (Sappey, Atlas.) *A*, *A*, Sternum; *B* to *K*, the first nine ribs; *L*, *M*, the ventral part of the diaphragm, part of the central tendon being shown at *M*; 1, 1, 1, 1, 2, 2, 2, the sternal plexus of lymphatic glands and the connecting vessels; 3 to 10, lymphatic network and trunks in the intercostal spaces. The trunks extend along the caudal margin of the ribs to reach the sternal glands. These trunks are directly continuous dorsad with the intercostal plexus (cf. Fig. 3280); 11, 11, vessels on the pleural surface of the diaphragm, finally extending to the sternal glands; 12, 12, 13, sternal glands opposite the eighth and ninth ribs and their efferent trunks; 14, glands receiving the lymphatics from the suspensory ligament of the liver.

* Sappey describes and figures in his Atlas[1] (Plate XLVIII., Fig. iii.) the lumbar trunks in the rabbit and the trunks from the ovary entering them without traversing any glands. He says further concerning the lumbar trunks, in describing the figure: "Gros troncs lymphatiques provenant des membres postérieurs et du bassin; ils se rendent directement dans l'origine du canal thoracique sans avoir traversé dans leur trajet aucun ganglion [lymphatique]." Such a condition was never observed by the writer in any of the white rabbits dissected.

lowed, this organ is a favorite object for study. The lymphatics extend from the peritoneal to the pleural surface, hence it is upon the thoracic face that the great trunks are found (Fig. 3276). These are arranged into three paired and one azygos group. The lymphatic trunks of the diaphragm practically surround the whole organ and the openings through it. From the ventral group, occupying somewhat more than the ventral half, the trunks extend toward the sternum, traverse a gland about opposite the seventh rib, and then extend to the sternal plexus, those of the right going to the right lymphatic trunk, and those of the left going to the thoracic duct (Fig. 3276). The azygos group appears opposite the xiphisternum, and is represented by three glands (supraxiphoid of Sappey, anterior mediastinal of authors), and their efferent trunks. These are not properly diaphragmatic lymphatics, for they come from the surface of the liver and suspensory

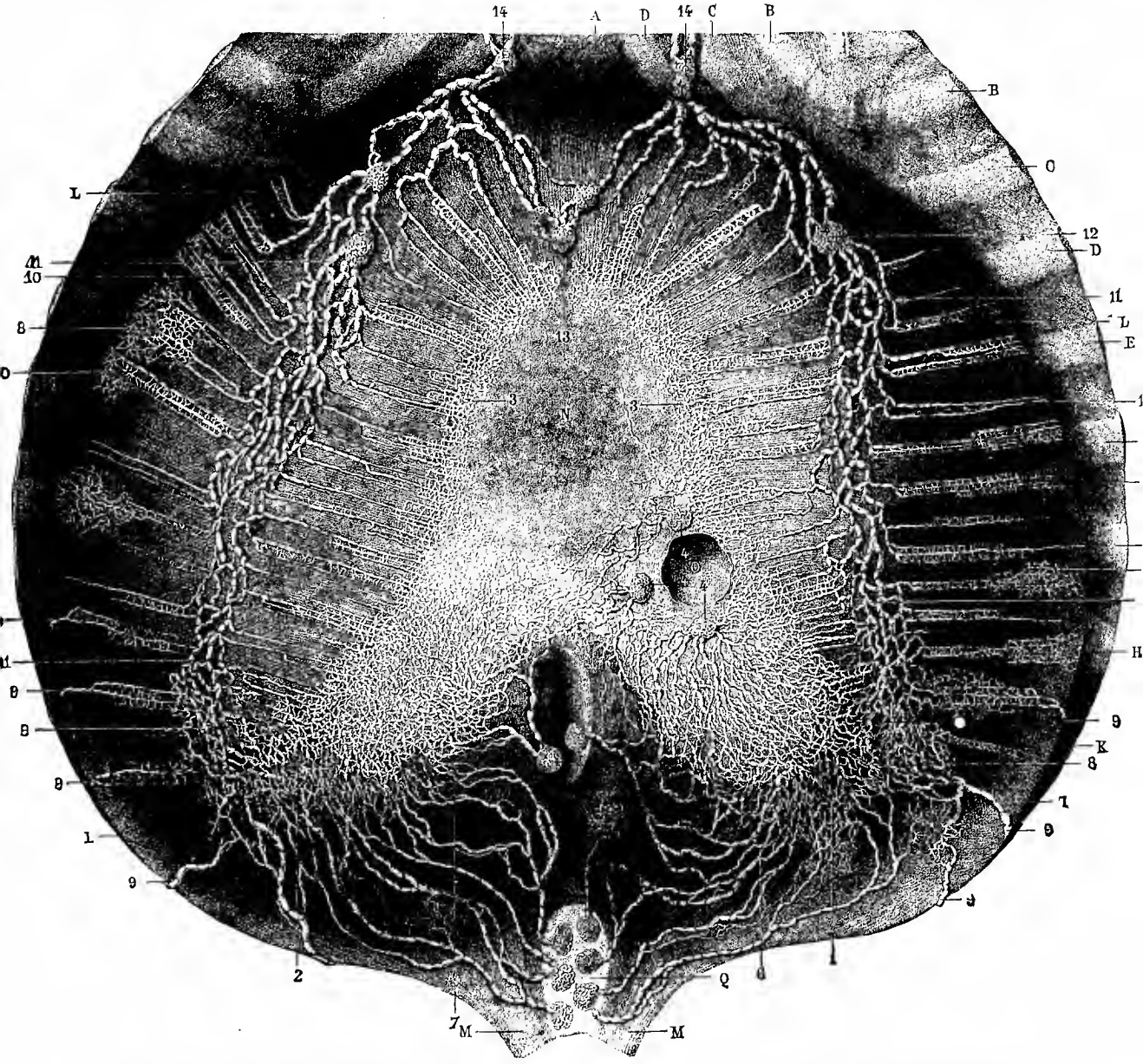


FIG. 3276.—The Lymphatic Vessels and Glands on the Pleural or Thoracic Aspect of the Human Diaphragm. (Sappey, Atlas.) *A*, Xiphisternum; *B*, *C*, *D*, *E*, *F*, *G*, *H*, *K*, 5, 6, 7, 8, 9, 10, 11, and 12, ribs; *L*, *L*, muscular part of the diaphragm next the ribs; *M*, *M*, pillars of the diaphragm; *N*, the three parts of the central tendon of the diaphragm; *O*, passage for the posteava; *P*, œsophageal orifice; *Q*, hiatus aorticus between the two pillars of the diaphragm. The glands in the opening are in the abdomen and belong to the cœliac lymphatic plexus. 1 and 2, The network in the right and left dorsal points of the central tendon; 3, 3, network around the border of the ventral or mesal part of the central tendon; 4, 4, 4, glands around the posteaval opening for the reception of part of the lymphatics of the Central tendon; 5, 5, two glands at the œsophageal opening, they receive the neighboring lymphatics; 6, 7, trunks coming from the dorsal part of the central tendon along the pillars of the diaphragm to enter the glands in the aortic opening at (*Q*); 8, 8, 8, the lymphatic network of the muscular part of the diaphragm; 9, 9, 9, 9, lymphatic trunks winding around the edge of the diaphragm to enter the cœliac lymphatic glands; 10 and 11, truncules and trunks extending toward the sternal plexus; 12, lymphatic gland on the diaphragm near its ventral attachment opposite the seventh rib; it is double on the left side; 13, three lymphatic glands ventral of the pericardium, and usually buried in fat. To them extend the lymphatics from the suspensory ligament of the liver; 14, 14, glands of the sternal plexus receiving the efferent vessels from 12 and 13 (cf. Fig. 3275).

ligament (see Liver). The efferent trunks join the sternal plexus.

From the dorsal part of the diaphragm the trunks converge to the aortic or œsophageal opening (dorsal group), and enter the glands there situated. Other trunks wind round the pillars of the diaphragm and enter the abdomen. As part of the glands in the aortic, and also in the œsophageal opening, are in the abdomen, it follows that part of the lymphatics starting on the peritoneal or abdominal side of the diaphragm extend to the pleural or thoracic side, and then turn back through these trunks into the abdomen before finally terminating in the thoracic duct.

The deep structures of the thoracic walls are drained by lymphatics following the intercostal spaces. As will be seen by consulting Figs. 3275 and 3280, the collecting trunks form a half-circle, the vessels extending both toward the sternal and toward the intercostal plexus. In their course along the intercostal spaces they usually traverse one or more glands. Near the spinal column is a row of glands whose efferent trunks may extend directly to the thoracic duct, but usually two or three of them unite to form a common trunk, which opens into the thoracic duct. It is a remarkable fact that those from the last three intercostal spaces unite to form trunks on each side, which extend through the diaphragm into the abdomen to join the chylocyst, instead of entering the thoracic duct in the thorax (cf. Fig. 3280, where vessels pass from the abdomen to the thorax).

From the first few intercostal spaces the collecting trunks on the right side pass to the right lymphatic trunk; and from the sternal half of all of the spaces the collecting trunks join the sternal plexus, those on the right extending therefrom to the right lymphatic trunk, and those on the left to the thoracic duct. This offers a very striking illustration of the close connection between the right and left lymphatic trunks in man, a condition much more fully realized in many of the lower animals. The lymphatics of the spinal canal and the muscles of the back follow their blood-vessels and enter the intercostal plexus, the greater number finally reaching the thoracic duct.

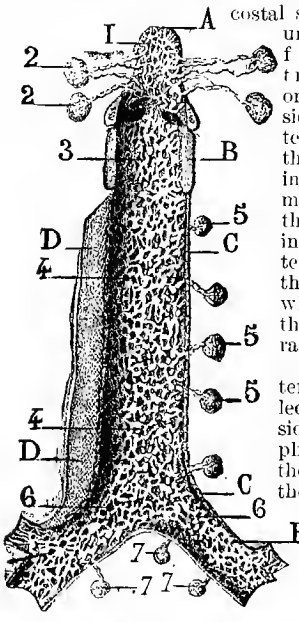


FIG. 3277.—Trachea and Bronchi Opened on the Dorsal Side to Show the Abundant Lymphatic Network of the Mucosa; from a Child at Birth. (Suppey, Atlas.) *A*, epiglottis; *B*, section of the cricoid cartilage to expose the interior of the larynx; *C*, *C*, trachea; *D*, *D*, the membranous portion of the trachea drawn to the left, exposing the interior; *E* and *F*, the two bronchi. 1, The lymphatic network of the epiglottis; 2, 2, ental cervical lymphatic glands (cf. Plate XLII., 13); subglottic network in the larynx; this is very sparing in the adult; 4, 4, network of the tracheal mucosa; 5, 5, ental cervical glands along the trachea into which the collecting trunks enter; 6, 6, the lymphatic network in the bronchi; it will be seen from this figure that the lymphatic network from the epiglottis into the bronchi is uninterruptedly dense; in the adult there are comparatively few lymphatics in the larynx proper and in the trachea; 7, 7, bronchial lymphatic glands.

Œsophagus.—The lymphatics of the œsophagus are in two sets, as in the rest of the alimentary canal, viz., those of the muscularis and those of the mucosa; they penetrate the muscular wall and enter the small glands scattered along its course. The lymphatics are directly continuous with those of the pharynx at one end and with those of the stomach at the other. At the gastric end the collecting trunks, after reaching the surface, extend toward the stomach, and part of them traverse the œsophageal opening and enter the glands around the cardia of the stomach (Plate XLIII.). Those of the middle region enter the dorsal (posterior) mediastinal glands, while those in the neck join the internal jugular plexus. Up to the present time the lymphatics of the muscularis have been actually demonstrated only in the larger domestic animals (horse and ox), but the probability is very strong, that they exist in the human œsophageal muscularis.

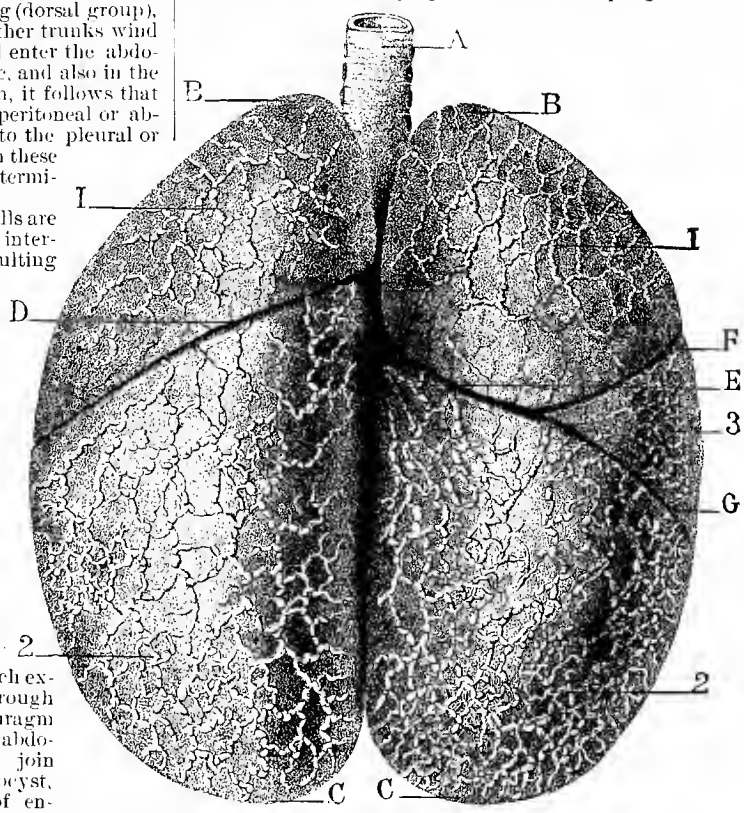


FIG. 3278.—Ectal or Subserous Lymphatics of the Dorsal Surface of the Lungs of a Child at Birth. (Suppey, Atlas.) *A*, trachea—the line points to the membranous portion; *B*, *B*, summit or cephalic lobes of the two lungs; *D*, the fissure dividing the left lung into two lobes; *E*, *F*, *G*, fissures dividing the right lung into three lobes. 1, Lymphatic network on the cephalic lobe; 2, 2, network on the caudal lobe; network on the middle lobe of the right lung. The fine network surrounding and covering the pulmonary lobules is not shown in this figure.

Heart.—The cardiac lymphatics are in two groups—a subpericardial and a subendocardial network—but in both cases they are derived from the muscular substance, and not from the serosa. The ectal or subpericardial network commences with the apex of the heart and extends over the whole surface, but the larger trunks occupy the dorsal and ventral grooves or depressions containing the large cardiac blood-vessels. The ental or subendocardial vessels unite into collecting trunks which penetrate the myocardium near the apex and near the auriculo-ventricular groove, and anastomose with the

ectal lymphatics, and all together extend to the groove between the auricles and ventricles, and form an anastomosing circle around the base of the ventricles. The rather few lymphatics of the auricles mostly extend tow-

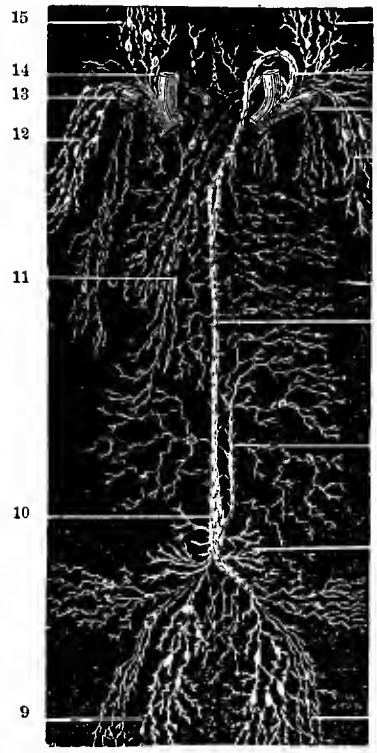


FIG. 3279.—Diagram of the Thoracic Duct, the Right Lymphatic Trunk, and the Lymphatic Plexuses of the Human Body. (After Quain.) 1, Left jugular plexus; 2, arch of the thoracic duct near its entrance into the angle between the subclavian and internal jugular veins; 3, left subclavian vein; 4, left axillary lymphatic plexus; 5, the thoracic duct in the thorax; 6, trunk from the intercostal plexus to the abdomen where it joins the chylocyst; there should be a similar trunk on the left (cf. Fig. 3280); 7, lacteals; 8 and 9, inguinal and iliac plexuses on the left and right; 10, chylocyst or chyle receptacle; 11, the sternal, bronchial, and mediastinal plexuses; 12, axillary plexus on the right; 13 and 14, right subclavian and internal jugular veins; the right lymphatic trunk enters the vein at the angle between the subclavian and internal jugular, as does the thoracic duct on the left; 15, right jugular lymphatic plexus.

ard the auriculo-ventricular groove and join the anastomosing ring, but some extend directly to the main trunks along the two sides of the pulmonary artery. From the anastomosing ring in the auriculo-ventricular groove two trunks arise, the one representing the left heart extends along the left side of the pulmonary artery, and between it and the left auricle to the left bronchial glands, and therefore finally to the thoracic duct. The trunk representing the right heart follows the right side of the pulmonary artery, and passes between this vessel and the arch of the aorta to reach the right bronchial glands, ultimately to terminate in the right common lymphatic trunk.

Lungs.—The lymphatics of the lungs are exceedingly numerous. They arise in the lung substance between the alveoli, and in the bronchial mucosa. Those near the surface extend toward the periphery and become subserous, and then extend to the root of the lung to enter the bronchial glands (Figs. 3277 and 3278). The ental lymphatics follow the bronchi and finally, after traversing a few small glands on the bronchi (the so-called pulmonary lymphatic glands), they enter the bronchial glands. From these glands extend trunks to the left to enter the thoracic duct, and to the right to enter the right common lymphatic trunk.

Trachea and Bronchi.—As seen above, the epiglottis and entire laryngeal opening possess an almost infinite number of lymphatics (Plate XLII.). In the infant this wealth of vessels continues throughout the entire larynx, and trachea and its branches; but as age advances the lymphatics of the larynx, commencing at the level of the vocal cords, and the trachea become less and less, until in the adult they are comparatively few; but in the smaller bronchi the abundant lymphatic network persists. The vessels arise in the mucosa and the intercartilaginous tissue, penetrate the tracheal wall, and are distributed to the glands so abundantly supplied to the neck along the trachea and bronchi (Fig. 3287).

THORACIC LYMPHATIC GLANDS.—The lymphatic glands of the thorax are only second in importance and number to those in the abdomen. Within the thorax they form a continuous network, and are closely connected with those of the abdomen on the one hand, and with those of the neck on the other. Those without the cavity are continuous with the axillary glands.

The pectoral glands (*glandulæ lymphaticæ pectorales, s. thoracicæ superficiales*) are situated along the caudal (inferior) border of the great pectoral muscle, and some more deeply along the vasa thoracica longa. Through them pass many of the trunks following the long thoracic blood-vessels, and many of those from the thoracic region on their way to the axillary lymphatic glands.

Within the thorax there are several named groups with corresponding plexuses. The sternal glands and plexus (*glandulæ lymphaticæ sternales, s. substernales, s. thoracicæ profundæ, s. mammariæ, s. prosternales; plexus lymphaticus sternalis, s. mammarius internus*) commence opposite the xiphisternum and extend along the thorax on each side of the sternum in company with the sternal blood-vessels (Fig. 3275). The afferent vessels of this plexus come from the deep abdominal muscles in the supra-umbilical region of the abdomen, the ventral two-thirds of the diaphragm, part of the convex surface of the liver through the suprahyoid glands, the structures in the intercostal spaces in the ventral part of the body. The afferent vessels usually join the ventral (anterior) mediastinal glands, and with their trunks pass to the two great common lymph-trunks. Sometimes one or more, or all, of the trunks pass directly to the great lymph-trunks without traversing the mediastinal glands.

The intercostal glands and plexus (*glandulæ lymphaticæ intercostales; plexus lymphaticus intercostalis*) are found on each side of the thorax, in the intercostal spaces, and along the vertebral column. The afferent vessels are from the intercostal structures, the spinal canal, and the deep muscles of the back. The efferent trunks pass mostly to the thoracic duct, but part of those on the right pass to the right lymphatic trunk.

The dorsal or posterior mediastinal glands and plexus (*glandulæ lymphaticæ mediastinales dorsales, s. posteriores; plexus lymphaticus mediastinalis dorsalis, s. posterior*) are situated along the thoracic aorta and the œsophagus, in the dorsal or posterior mediastinal folds. The afferent vessels are from the œsophagus, the dorsal third of the diaphragm, and some from the liver. The efferent vessels enter the thoracic duct, directly, or join the bronchial glands.

The ventral (anterior) mediastinal glands and plexus (*glandulæ lymphaticæ mediastinales ventrales, s. anteriores, s. gl. l. cardiacæ; plexus lymphaticus mediastinalis ventralis, s. anterior*) are in the ventral mediastinal fold, and are principally concentrated around the arch of the aorta and the roots of the great blood-vessels. The glands called supra-xiphoid by Sappey (14 of Fig. 3275) are frequently assigned to this group. The afferent vessels are from the sternal plexus, and through this many vessels from the convex surface of the liver; the lymphatics of the thymus, and, according to some authors, the lymphatics of the heart. The efferent vessels either go to the bronchial glands or join the vessels from these, and extend from the right half to the right lymphatic trunk, and from the left half to the thoracic duct.

The bronchial glands and plexus (*glandulæ lymphaticæ*

bronchiales; plexus lymphaticus bronchalis) are situated in the bifurcation of the trachea, and extend upon the trachea (where they are called tracheal lymphatic glands) to the internal jugular plexus, and others extend out along the bronchi into the lungs (pulmonary lymphatic glands). In childhood and youth they are pink, but with advancing age they become dark and even black, if the individual has inhaled a plentiful supply of coal dust or other carbonaceous matter. These glands are very large and important. The afferent vessels are from the lungs, and, according to some authors, the heart, the bronchi, the efferent vessels of the dorsal mediastinal glands, and sometimes the ventral mediastinal glands also. The efferent vessels extend from the left side to the thoracic duct, and from the right to the right lymphatic trunk. Frequently the efferent vessels of the sternal, ventral, mediastinal, and bronchial glands unite to form a large single or multiple trunk (*truncus lymphaticus bronchomediastinalis s. bronchomediastinus, s. bronchomediastinicus*), which extends to the common lymphatic trunk of the right or left. Such a trunk is more common on the right. On the left the efferent trunks are usually smaller and less concentrated.

Common Lymphatic Trunks.—In man and the mammals there are but two common lymphatic trunks, one on the right and one on the left side; and these trunks terminate at two points in the great veins of the neck, usually at the junction of the jugular and subclavian veins—that is, just before the formation of the brachiocephalic venous trunks, or in animals like the rabbit (Fig. 3287) with a right and left precava, just before the formation of these. In man and the higher animals these trunks are of different length and size, and receive the lymphatics of very unequal portions of the body, that on the left side being normally much the more extensive. In the lowest mammals the tendency is very strong to equalize these trunks, and also the area drained by them; and in the animals below mammals, the two are approximately equal.

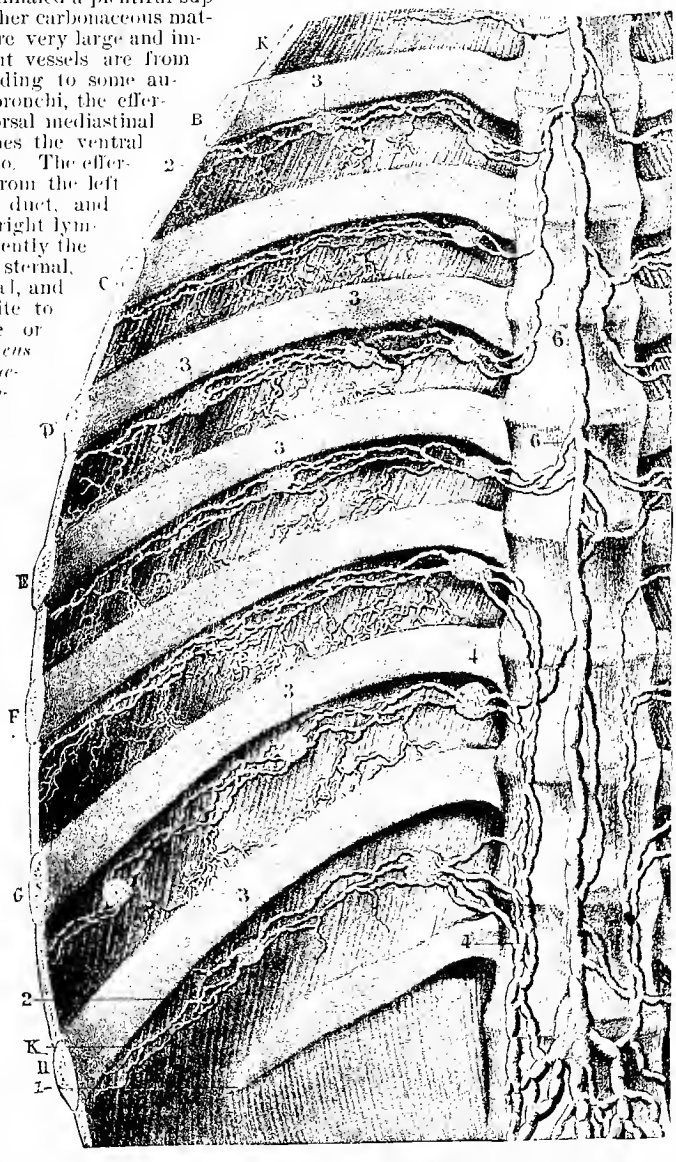


Fig. 3280.—Part of the Thoracic Duct and Intercostal Lymphatics. (Sappey, Atlas.) *A*, vertebral column opposite the first lumbar vertebra; *B*, *C*, *D*, *E*, *F*, *G*, *H*, *I*, fifth to the twelfth ribs inclusive; *K*, ectal intercostal muscles between the ribs; the ental or internal intercostals have been removed to show the intercostal lymphatic plexus; 1, the thoracic duct near the chylocyst; it extends along the vertebral column nearly on the meson; 2, 2, trunks arising in the intercostal spaces; 3, 3, 3, lymphatic glands in the course of the vessels; 4, 4, large trunk conveying the lymph from the three or four intercostal spaces into the abdomen and then pouring it into the chylocyst; 5, 5, similar trunk on the left side; 6, 6, and 7, trunks on the right and left, from the intercostal spaces to the thoracic duct.

Thoracic Duct (*chyloductus, ductus thoracicus, s. truncus, s. canalis lymphaticus communis sinister, s. major, s. ductus chyliferus, s. lumbothoracicus; vena alba thoracis* [Eustachius, 1564]).—The common lymphatic duct, canal, or trunk of the left side collects and empties into the venous system, the lymph of the pelvic limbs, the reproductive and urinary organs, the alimentary canal, pancreas, spleen, much of that of the liver, of the left half of the body cephalad of (above) the umbilicus and a part of that from the right half of the thoracic wall (Figs. 3279 to 3287).

In man the thoracic duct is formed in the abdomen opposite the first, second, or third lumbar vertebra by the union of the trunks of the lumbar and mesenteric lymphatic plexuses. The caudal end is formed by the union of the right and left lumbar trunk (*truncus lymphaticus lumbalis dexter et sinister*). The large trunk thus formed is then increased by the addition of the unpaired or azygous trunk (*truncus intestinalis*) from the stomach and intestines, part of the liver, the spleen and pancreas, and the right and left trunk from the intercostal plexuses (Fig. 3279). At the beginning of the duct where all these confluents unite there is usually a marked dilatation, the chylocyst, chyle receptacle, or cistern of Pecquet (*chylocystis, s. receptaculum chyli, s. cisterna chyli*). This is sometimes absent in man as the confluents form a kind of network instead of one large trunk. In this case the thoracic duct is formed by the union of the network without there being present a special enlargement or chylocyst. This condition is said by Owen to be normal in the marsupials examined by him, but in the dog, cat, rabbit, and most of the higher animals there is usually a very well-marked chylocyst. From the chylocyst the thoracic duct traverses the diaphragm with the aorta, usually on the

right side, and extends along the thorax mostly on the right and dorsal side of the aorta until opposite the sixth to the third thoracic vertebra it gradually inclines to the left, passes dorsad of the arch of the aorta, reaches the left side of the œsophagus which it follows for a short distance, passing on with it along the dorsal side of the great blood-vessels until opposite the seventh cervical vertebra when it forms an arch something like the arch of the aorta, curving ventrad and to the left between the vertebral blood-vessels and the jugular vein to terminate at the junction of the left internal jugular and the subclavian vein. The opening is guarded by a double valve, so that reversal of the direction of the stream is avoided.

The thoracic duct differs in length with the length of the trunk. The average in an adult is about 40 cm., and its diameter is about 2 to 3 mm., it being greater near its origin than near its termination. It in many cases divides into two or more parallel and anastomosing vessels, which finally unite to enter the vein together. The chylocyst is from 40 to 50 mm. long and 6 to 8 mm. in diameter, and in the arch near the termination there is sometimes, if not regularly, found a dilatation something like that shown in the dog and the rabbit (Figs. 3285 and 3287). The thoracic duct receives confluent branches throughout its entire course, and near the termination enter the important trunks from the arm, lungs, and head and neck (the jugular, subclavian, and broncho-mediastinal trunks). The entrance of each of these vessels is usually guarded by a paired valve.

Varieties.—There are sometimes two ducts — one opening into the right, and one into the left veins of the neck. Sometimes a single duct divides, sending one branch to the right and one to the left, as shown in the figure of the cat and rabbit (Figs. 3282 and 3287). Rarely there is a transposition, the left thoracic duct opening on the right. "In two instances the thoracic duct has been seen to terminate in the vena azygos." Multiple openings into the veins are not uncommon (cf. Fig. 3283).

Right common lymphatic trunk (truncus lymphaticus communis dexter, s. minor; vena

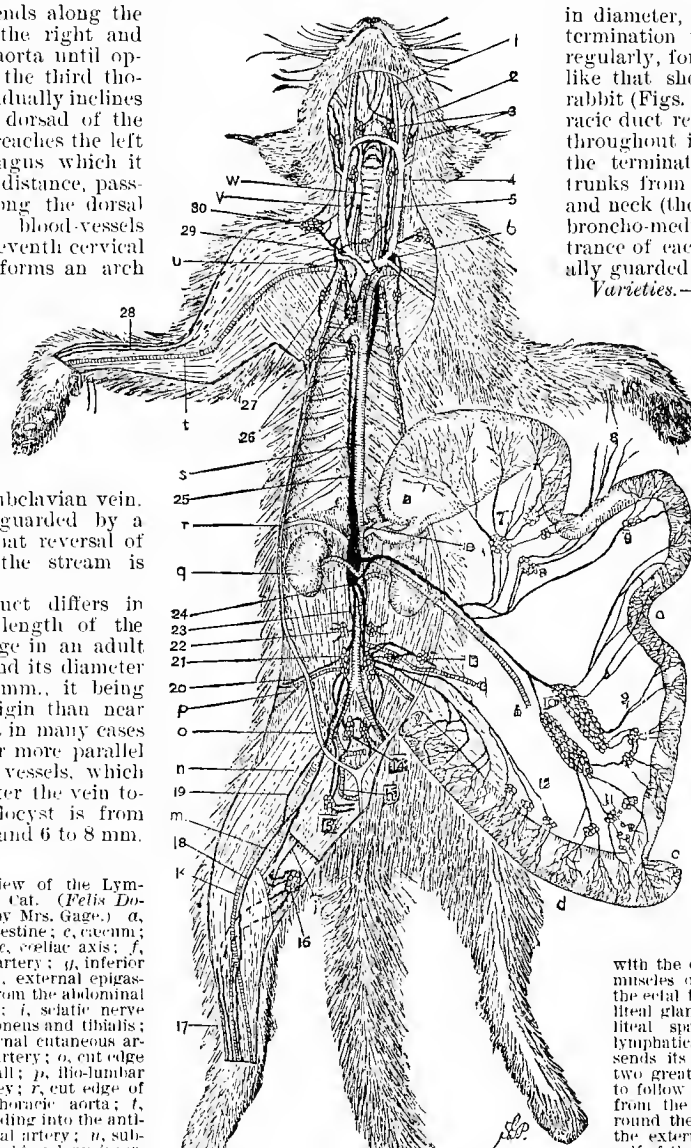


Fig. 3281.—General View of the Lymphatic System of the Cat. (*Felis Domestica.*) (Drawn by Mrs. Gage.) *a*, Stomach; *b*, small intestine; *c*, cæcum; *d*, large intestine; *e*, cœliac axis; *f*, superior mesenteric artery; *g*, inferior mesenteric artery; *h*, external epigastric artery reflected from the abdominal wall upon the thigh; *i*, sciatic nerve dividing into the peroneus and tibialis; *k*, saphenous or internal cutaneous artery; *m*, *n*, femoral artery; *o*, cut edge of the abdominal wall; *p*, ilio-lumbar artery; *q*, right kidney; *r*, cut edge of the diaphragm; *s*, thoracic aorta; *t*, brachial artery, extending into the antibrachium as the radial artery; *u*, subclavian vein; *v*, external jugular vein; *w*, trachea. 1, Lymphatics from the ventral lip and floor of the mouth to the two submaxillary lymphatic glands. As shown in the figure, these trunks cross to the opposite side from which they arose; 2, trunks from the facial region injected from the bare spot on the snout and dorsal lip; 3, the two submaxillary lymphatic glands, one on each side of the facial vein; 4, single ental cervical gland on the side of the trachea and next the carotid artery; into this enter most of the efferent trunks from the submaxillary lymphatic glands; 5, *truncus lymphaticus jugularis* from the ental cervical glands to the thoracic duct on the left, and the right common lymphatic trunk on the right; 6, termination of the thoracic duct at the junction of the subclavian and external jugular veins; 7, lymphatics from the stomach to the cœliac glands; 8, lymphatics from the liver to a cœliac gland; 9, gland near the duodenum into which many of the duodenal lymphatics enter; 10, the two enormous mesenteric glands near the cæcum, often called the glands or pancreas of Asellius, into which most of the lymphatics of the small intestine, cæcum, and part of the colon empty. From these glands extends the great *truncus lymphaticus intestinalis* to the chylocyst, receiving the trunks from the duodenum, liver, and stomach on its way; in the cat, as shown in the figure, the truncus intestinalis is very long and usually single, making it very easy to insert a cannula for a starch or plaster injection; 11, trunks and glands in the cæcal region; 12, lymphatics from the colon, there are usually several small glands near the attachment of the mesentery; 13, glands in the mesocolon around the inferior mesenteric blood-vessels; 14, hypogastric lymphatic glands; 15, gland at the side of the external epigastric blood-vessels. It receives the lymphatics from the abdominal wall, part of the mammary gland and the external genitalia, its efferent vessels go partly to the hypogastric and partly to the lumbar lymphatic glands; the gland has been reflected from the abdominal wall with the external epigastric artery to the muscles of the thigh, it may represent the ectal inguinal group of man; 16, popliteal gland in a mass of fat in the popliteal space. It receives most of the lymphatics of the foot and crus, and sends its efferent trunks between the two great branches of the sciatic nerve to follow the femoral artery; 17, trunks from the dorsum of the foot, winding round the fibular side of the crus with the external saphenous vein across the calf of the leg to the popliteal gland, part of the course is indicated by broken lines; 18, lymphatic trunk from the dorsum and tibial side of the foot following the saphenous or internal cutaneous artery, about opposite to the middle of the thigh it anastomoses freely with those following the femoral vessels; 19, lymphatic trunks accompanying the femoral blood-vessels and finally entering the lumbar glands, no inguinal glands being present; 20, lymphatic trunk accompanying the ilio-lumbar blood-vessels and entering the lumbar lymphatic glands; 21, lumbar lymphatic glands; 22, lumbar glands into which pass the lymphatic trunks from the internal genitalia, these are frequently merged with the preceding; 23, *truncus lymphaticus lumbalis*, there is one on each side, but frequently the trunks are multiple, and the branches of the two sides anastomose, they form principal constituents of the chylocyst; 24, chylocyst formed by the junction of the intestinal and lumbar trunks; 25, thoracic duct, a small branch is indicated as going to the right side of the body; 26, lymphatic glands in the thorax, near the arch of the aorta and bronchi; 27, pectoral lymphatic glands in course of the long thoracic blood-vessels; 28, lymphatics from the dorsum of the manus following the radial nerve and cephalic vein, and finally terminating in the prescapular gland. The course in the brachium, where not visible in this view, is indicated by broken lines, occasionally one or more branches turn at the elbow to follow the brachial vessels into the axilla; in this case they enter the pectoral gland opposite the third rib, true axillary glands appearing to be absent; 29, termination of the right common lymphatic trunk at the junction of the subclavian and external jugular vein; 30, prescapular gland receiving the lymphatics of the arm and shoulder, and usually an anastomosing branch from the jugular trunk, its efferent vessels join the jugular trunk.

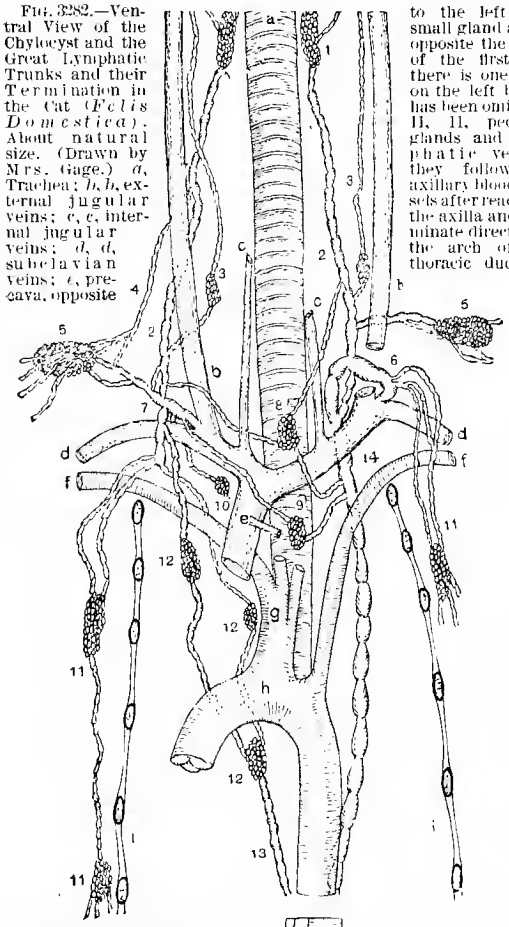


FIG. 3282.—Ventral View of the Chylocyst and the Great Lymphatic Trunks and their Termination in the Cat (*Felis Domestica*). About natural size. (Drawn by Mrs. Gage.) *a*, Trachea; *b*, *b*, external jugular veins; *c*, *c*, internal jugular veins; *d*, *d*, subclavian veins; *e*, precava, opposite the entrance of the common trunk of the sternal veins; *f*, *f*, subclavian arteries; *g*, brachiocephalic artery opposite its division into the right subclavian, the right and left carotids; *h*, *h*, arch of the aorta and abdominal aorta; *i*, *i*, cut edges of the thoracic walls and the ends of the ribs; *k*, *k*, pillars of the diaphragm; *m*, coeliac axis; *n*, superior mesenteric artery; *o*, *o*, the renal arteries. 1, Ental cervical gland; 2, *truncus lymphaticus jugularis*; 3, 3, trunk and gland along the external jugular vein, the trunk is one of the efferent vessels from the lateral of the two submaxillary lymphatic glands (cf. Fig. 3281); 4, anastomosing branches between the jugular trunk and the efferents from the prescapular gland; 5, 5, the right and left prescapular gland; 6, termination of the thoracic duct in the veins at the angle of the subclavian and external jugular, a short segment has been removed from the external jugular to show more clearly the arch of the terminal part of the thoracic duct; 7, the right common lymphatic trunk at its termination; 8, lymphatic gland on the trachea, its efferent vessels extend both to the right and to the left; 9, large gland in the ventral mediastinum around the sternal vessels, its efferent vessels extend both to the right and to the left; 10, small gland about opposite the head of the first rib, there is one also on the left but it has been omitted; 11, 11, pectoral glands and lymphatic vessels, they follow the axillary blood-vessels after reaching the axilla and terminate directly in the arch of the thoracic duct on the left, but join other trunks on the right before entering the common trunk; 12, 12, 12, lymphatic glands and trunk near the arch of the aorta, the efferent vessels form prominent constituents of the right lymphatic trunk; 13, branch of the thoracic duct turning to the right and finally terminating in the right lymphatic trunk; 14, 14, thoracic duct. As indicated by the constrictions the valves are considerably farther apart in the cephalic half; 15, 15, chylocyst on the right side of the aorta and extending for a considerable distance into the thorax; 16, *truncus intestinalis*, the common trunk from the stomach, liver, and intestines (cf. Fig. 3281). Before terminating in the chylocyst it divides into several branches, one of which winds round the left side of the aorta, one sends a branch to a small gland near the origin of the superior mesenteric artery and from this gland the efferent trunk passes laterad of the pillar of the diaphragm, enters the thorax with the splanchnic nerves and terminates in the thoracic duct just beyond the chylocyst; still another branch anastomoses with the lumbar trunks; the lymphatics form a perfect maze in this region, so that it is no wonder Eustachius was bewildered in his first investigation of them; 17, lymphatic vessels from the abdomen to enter the thoracic duct in the thorax; this seems like an exact reversal of the condition in man where some of the lymphatics of the thorax (intercostal plexus) enter the abdomen to assist in forming the chylocyst (cf. Fig. 3280); 18, left and 19, right anastomosing trunks from the lumbar glands.

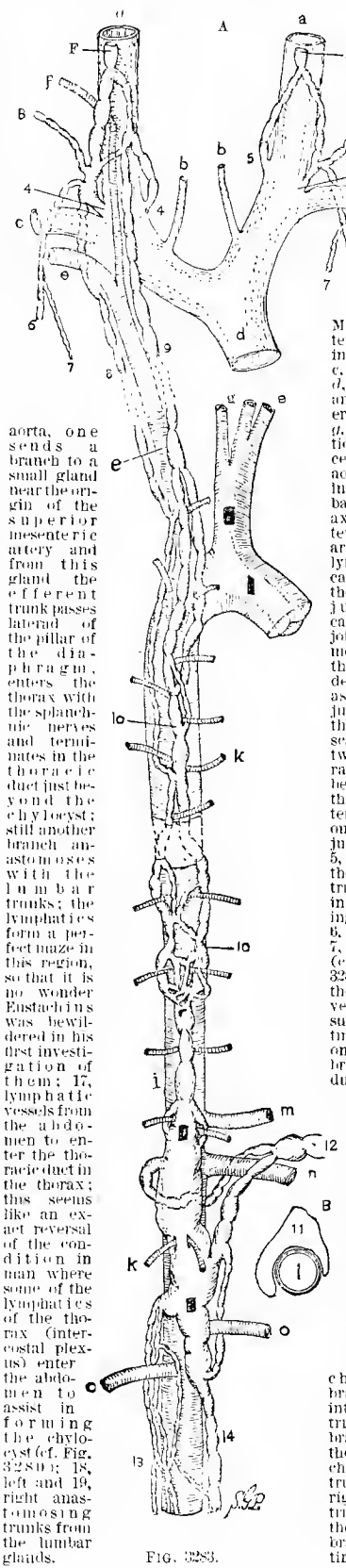


FIG. 3283.—Dorsal View of the Chylocyst and the Great Lymphatic Trunks in their Relation to the Blood-vessels of the Cat (*Felis Domestica*). Slightly more than natural size. The blanks and dotted lines indicate the omission of a part of the length. (Drawn by Mrs. Gage.) *a*, *a*, External jugular veins; *b*, *b*, internal jugular veins; *c*, *c*, subclavian veins; *d*, precava; *e*, the right and left subclavian arteries; *f*, left thyroid axis; *g*, between the two carotid arteries; *h*, brachiocephalic artery; *i*, *i*, *i*, aorta; *k*, *k*, upper one an intercostal, lower a lumbar artery; *m*, coeliac axis; *n*, superior mesenteric artery; *o*, *o*, renal arteries. 1, Left jugular lymphatic trunk, bifurcating and joining the thoracic duct; 2, right jugular trunk, bifurcating and one branch joining the right common lymphatic trunk, the other terminating independently in the mesal aspect of the external jugular; 3, 3, trunks from the right and left prescapular glands; 4, 4, the two openings of the thoracic duct, the lateral one being at the junction of the subclavian and external jugular, the mesal one into the external jugular about opposite; 5, 5, the two openings of the right lymphatic trunks—they are similar in position to the openings of the thoracic duct; 6, 6, pectoral lymphatics; 7, 7, thoracic lymphatics (cf. 11 and 12 of Fig. 3282); 8, branch of the thoracic duct on the ventral side of the great subclavian vessels, sometimes the entire duct is on the ventral side; 9, branch of the thoracic duct on the dorsal side of the subclavian blood-vessels this is the position of the entire duct in about three-fourths of the numerous specimens examined; 10, 10, greatly divided thoracic duct. The thoracic duct is never simple in the cat throughout its whole course, but this one is more than commonly divided; 11, 11, 11, chylocyst. On the right is drawn a section at this point to show that the chylocyst nearly embraces the aorta; 12, intestinal lymphatic trunk sending a large branch on both sides of the aorta to enter the chylocyst; 13, left lumbar trunk greatly divided; 14, right lumbar lymphatic trunk anastomosing with the left and with a branch from the intestinal trunk.

lymphatica dextra).—The right common lymphatic trunk is only about 14 mm. long, but is nearly as great in diameter as the thoracic duct. It is formed by the confluence of the lymphatics from the right side of the head (*truncus lymphaticus jugularis dexter*), those from the right arm, shoulder, and breast (*truncus lymphaticus subclavius*), the efferent trunks from the right half of the sternal, and ventral mediastinal and bronchial plexuses (*truncus bronchomediastinalis dexter*). As stated above, a part of the lymphatics of the right costal region open into the left thoracic duct (Fig. 3280). As on the left side there is a tendency for the trunk to terminate by a multiple instead of a single opening. Not infrequently, there is no true common trunk formed, but the great trunks from the different regions open separately.

The great lymphatic trunks in the higher mammals conform quite closely to those of man, but the termination varies somewhat. When the internal jugular is small it is generally near the junction of the subclavian and external jugular (Figs. 3282, 3285, and 3287), in the horse

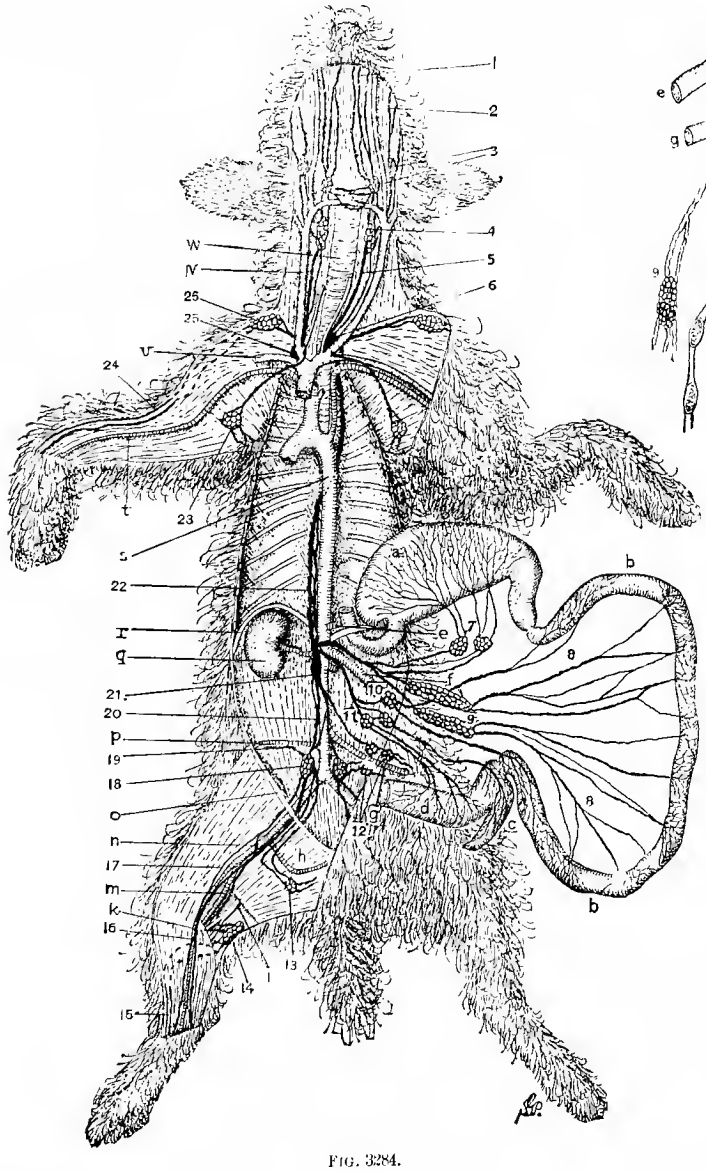
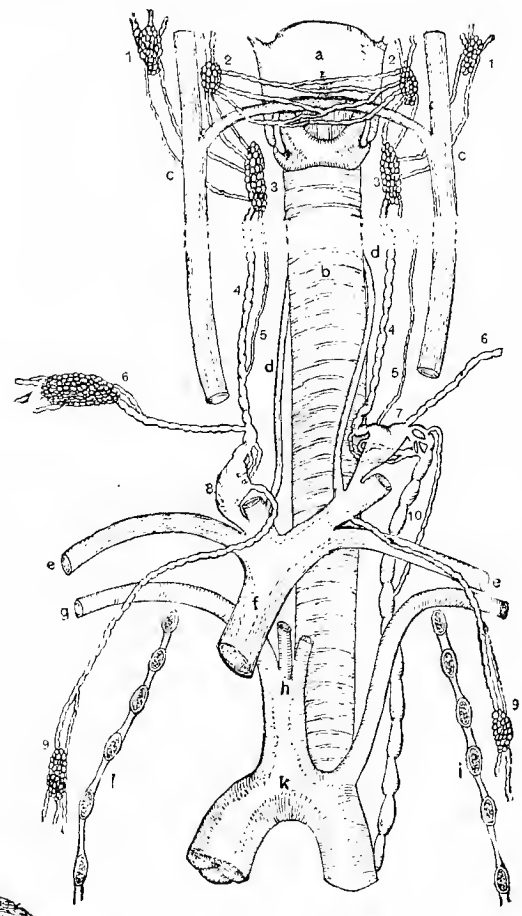


FIG. 3284.



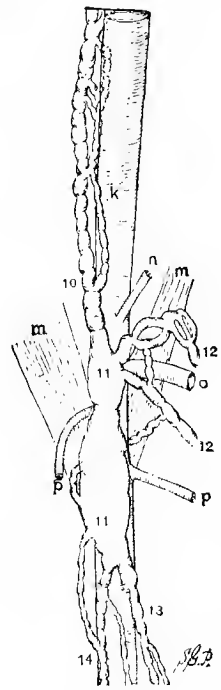


FIG. 3285.

FIG. 3284.—General View of the Lymphatic System of the Dog (Scotch Terrier). (Drawn by Mrs. Gage.) *a*, Stomach; *b*, *b*, small intestine; *c*, cæcum; *d*, large intestine; *e*, cœliac axis; *f*, superior mesenteric artery; *g*, inferior mesenteric artery; *h*, epigastric artery displaced from the abdominal wall to the muscles of the thigh; *i*, sciatic nerve and other popliteal structures brought into view by removing a segment of the thigh muscles; *k*, saphenous or internal cutaneous artery; *m*, *n*, the femoral artery; *o*, cut edge of the abdominal wall; *p*, ilio-lumbar artery; *q*, right kidney; *r*, cut edge of the diaphragm; *s*, aorta; *t*, brachial artery and its continuation as the radial artery in the anti-brachium; *u*, subclavian vein; *v*, external jugular vein; *w*, trachea. 1, Lymphatic trunks from the ventral lip to the mesal of the two submaxillary lymphatic glands; 2, lymphatic trunks from the face and nose, and dorsal lip, injected from the snout; 3, the two submaxillary lymphatic glands with the facial vein between them—the mesal glands of the two sides are connected by several transverse vessels; 4, ental cervical gland; 5, jugular lymphatic trunk finally joining the thoracic duct on the left, the right lymphatic trunk on the right; 6, termination of the thoracic duct at the junction of the subclavian and external jugular veins; 7, cœliac glands receiving the lymphatics of the stomach, and sending efferent trunks to the intestinal trunk; 8, lymphatic or lacteal trunks from the small intestine; 9, two large mesenteric glands (so-called glands of Asellius or pancreas Aselli; from these originates the intestinal lymphatic trunk, which is quite short in the dog and much more difficult to inject than in the cat; 10, gland receiving trunks from the duodenum, ileum, and large intestine near the cæcum; 11, glands receiving the lymphatics from the cæcum, and part of the large intestine; 12, glands in the meso-colon along the inferior mesenteric artery; they receive vessels from the large intestine, and the efferent vessels go to the chylocyst and to the lumbar glands; 13, gland on the abdomen beside the external epigastric artery; 14, popliteal gland; 15, lymphatics from the foot, following the external or short saphenous vein around the calf of the leg into the popliteal gland; the parts of the vessels that would be hidden in this view are indicated by broken lines; 16, lymphatic trunk following the saphenous artery. The saphenous trunk freely anastomoses with the trunk following the femoral artery, and with it passes to the lumbar glands; 18, lumbar lymphatic glands; 19, lymphatic trunk, accompanying the ilio-lumbar artery, and terminating in the lumbar glands; 20, lumbar lymphatic trunks; 21, chylocyst; 22, thoracic duct, double for a considerable distance; 23, pectoral lymphatic gland and vessels; 24, lymphatic trunks following the cephalic vein, and terminating in the prescapular gland. The course along the brachium is indicated by broken lines, as the vessels would not appear in this view; 25, termination of the right lymphatic trunk; 26, prescapular lymphatic gland of the right side.

FIG. 3285.—Ventral View of the Chylocyst and the Great Lymphatic Trunks in their Relation to the Principal Blood-vessels of the Dog (Scotch Terrier). The blanks with dotted lines in the cervical region, and the blank in the thorax, indicate that part of the length has been omitted. About natural size. (Drawn by Mrs. Gage.) *a*, Larynx; *b*, trachea; *c*, *c*, the right and left external jugular veins, with segments removed; *d*, *d*, the two internal jugular veins; *e*, *e*, subclavian veins; *f*, precava; *g*, *g*, right and left subclavian arteries; *h*, brachio-cephalic artery, near its division into the subclavian and the two carotids; *k*, *k*, aorta; *m*, *m*, pillars of the diaphragm; *n*, *n*, cœliac axis; *o*, superior mesenteric artery; *p*, *p*, renal arteries. 1, 1, Right and left lateral submaxillary lymphatic glands, receiving trunks from the face, nose, and dorsal lip; 2, 2, mesal submaxillary lymphatic glands, receiving trunks from the ventral lip; these two glands are connected by numerous anastomosing and crossing trunks; 3, 3, ental cervical glands, receiving the efferents from 1 and 2; 4, 5, 4, 5, jugular trunks from the ental cervical glands to the thoracic duct and right common lymphatic trunk; 6, 6, trunks from the prescapular glands, only the right gland being shown; 7, termination of the thoracic duct on the mesal surface of the external jugular, near its junction with the internal jugular vein. The arch in the duct is on the dorsal side of the great subclavian vessels, and it arches toward the meson instead of laterad as with the cat, and before terminating enlarges considerably. Into the enlargement terminate the jugular trunks and the one from the prescapular gland; the enlargement narrows markedly before entering the vein; 8, enlargement and termination of the right lymphatic trunk; 9, 9, pectoral glands and trunks; the one on the left terminates independently in the lateral aspect of the external jugular, near its junction with the subclavian; 10, 10, thoracic duct; it is considerably divided just within the thorax, and then again just before enlarging near its termination; 11, 11, chylocyst on the ventral and right side of the aorta, and extending for a short distance into the thorax; 12, 12, intestinal lymphatic trunks; one branch winds round the left side of the aorta, and terminates finally on the right side of the chylocyst; 13, left lumbar lymphatic trunk; 14, right lumbar lymphatic trunk.

FIG. 3286.—General View of the Lymphatic System of a White Rabbit. (Drawn by Mrs. Gage.) *a*, Stomach; *b*, *b*, small intestine; *c*, *c*, cæcum; *d*, the so-called vermiform appendix; *e*, large intestine; *f*, cœliac axis; *g*, superior mesenteric, and *h*, inferior mesenteric artery; *i*, external epigastric artery displaced from the abdominal wall to the muscles of the thigh; *k*, sciatic nerve and other popliteal structures exposed by removal of a segment of the thigh muscles; *m*, saphenous or internal cutaneous artery; *n*, *o*, femoral artery; *p*, cut edge of the abdominal wall; *q*, ilio-lumbar artery; *r*, right kidney; the left has been omitted, although the beginning of the renal artery is shown; *s*, cut edge of the diaphragm; *t*, aorta; *u*, brachial and ulnar artery; *v*, subclavian vein; *w*, external jugular vein; *x*, trachea. 1, Trunks from the ventral lip and sides of the mouth; 2, trunks from the snout; 3, the two submaxillary lymphatic glands on either side of the facial vessels; 4, lymphatic glands near the base of the ear; 5, ental cervical lymphatic gland; 6, left jugular lymphatic trunk on its way to join the thoracic duct; 7, thoracic duct near its termination in the vein; 8, cœliac glands, receiving the lymphatics of the stomach; 9, 9, lacteals from the small intestine to 10, the great mesenteric gland (gland or pancreas of Asellius); it gives rise to two intestinal trunks, which are short, small, and difficult to inject with a coarse mass; 11, large mesenteric gland receiving the vessels from the mass of lymphoid follicles at the termination of the ileum; 12, lymphoid tissue, *sacculus rotundus*, at the termination of the ileum; 13, gland receiving the lymphatic trunks from the vermiform appendix; 14, glands in the meso-colon along the inferior mesenteric vessels; the efferent vessels pass to the lumbar trunks; 15, hypogastric or sacral lymphatic gland; 16, gland on the abdomen by the external epigastric vessels—it has been displaced with the artery to the thigh muscles; 17, popliteal glands receiving vessels from both sides of the crus, sending efferent branches between the peroneal and tibial nerves to follow the femoral artery, and another to accompany the ischiadic artery; 18, lymphatic trunks from the dorsum of the foot, winding round the tibial or outer side of the calf to join the popliteal gland; 19, lymphatic following the saphenous artery; it usually divides near the knee, sending one branch to the popliteal gland; 20, lymphatic trunk extending along with the femoral artery; it is formed by the intimate anastomosis of those accompanying the saphenous and deep femoral arteries; 21, lumbar lymphatic glands; 22, subcutaneous lymphatic gland near the ilio-lumbar blood-vessels, just at the lateral margin of the sartorius muscle; the efferent lymphatics follow the ilio-lumbar vessels and enter the lumbar glands; 23, lumbar lymphatic trunks; the right one is much more divided than the left; 24, chylocyst; 25, thoracic duct; this is almost invariably more or less divided and sends out a considerable branch to the right lymphatic trunk; 26, pectoral lymphatic glands; 27, anasto-

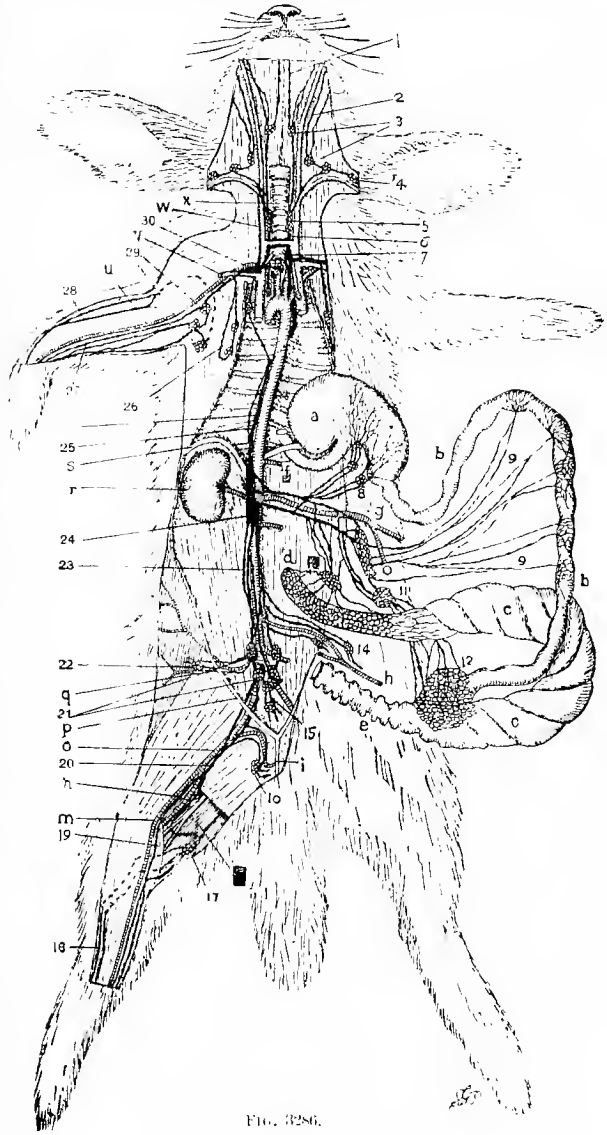


FIG. 3286.

mosing trunks following the radial and brachial artery to the axillary glands; 28, trunk following the radial nerve, winding round the brachium to terminate in the axillary glands also; the broken line indicates that the trunk would be out of sight in this view; 29, axillary lymphatic glands; these are not very closely connected with the axillary vessels; 30, termination of the right lymphatic trunk.

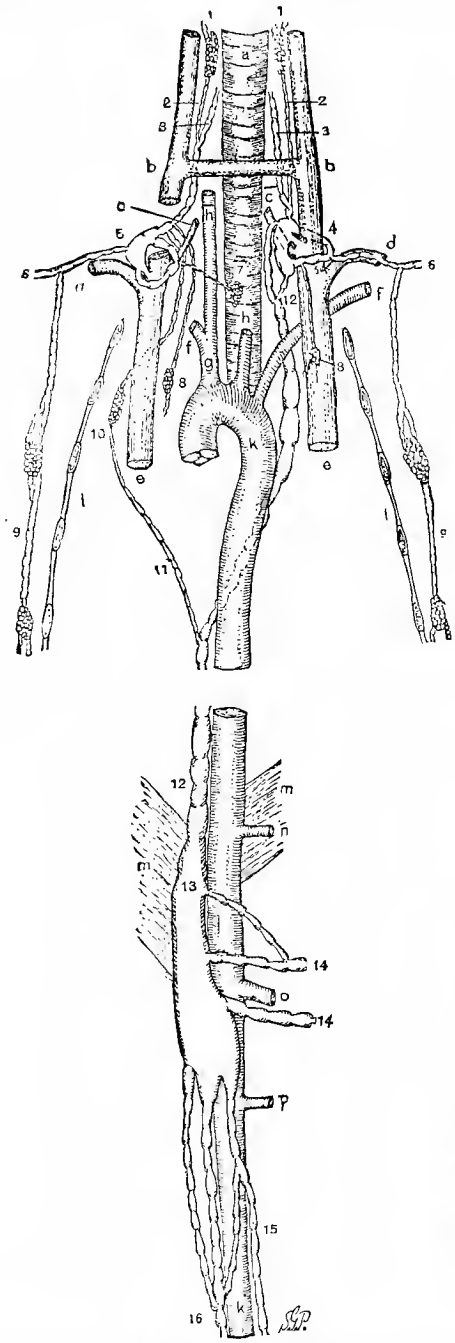


FIG. 3287.—Ventral View of the Chylocyst and the Principal Lymphatic Trunks in their Relation to the Great Blood-vessels in the White Rabbit. (Drawn by Mrs. Gage.) *a*, Trachea; *b*, *b*, external jugular veins connected by a transverse vessel; *c*, *c*, internal jugular veins; on the right a segment is removed from the jugular better to show the branches forming the right lymphatic trunk; *e*, *e*, the two internal jugular veins; *d*, *d*, the subclavian veins; *e*, *e*, the right and left precavæ; *f*, *f*, the two subclavian arteries; *g*, brachiocephalic artery dividing into the right subclavian and the right carotid; *h*, *h*, carotid arteries, the left arises from the arch of the aorta; *i*, *i*, cut thoracic wall and ends of five of the ribs; *k*, *k*, aorta; *m*, *m*, pillars of the diaphragm; *n*, cœliac axis; *o*, superior mesenteric artery; *p*, left renal artery, the right not being shown. 1, 1, Two ental cervical glands; 2, 2, efferent trunks of the ental cervical glands; 3, 3, ectal lymphatic trunks from the glands near the ear; they follow the external jugular vein for a considerable distance, then penetrate the tissues to join the jugular trunk; 4, the termination of the thoracic duct; this is very complex, forming a ring around the jugular, and becoming ampulliform, it terminates by a narrowed neck at the junction of the external and internal jugular veins; the numerous trunks opening into the expanded end of the thoracic duct, have their mouths guarded by a paired valve; 5, termination of the right lymphatic trunk; it is expanded like the thoracic duct and receives many trunks. The external jugular vein is encircled as on the left. A segment of the vein has been removed, better to show the parts. The right trunk opens into the vein at the junction of the right subclavian and external jugular, as is the usual method on both sides in the dog and cat; 6, 6, right and left trunks from the axillary glands; 7, tracheal gland with trunk going to the right; there is probably one going to the left also, as with the cat; 8, 8, glands in the thorax sending their efferent trunks to the corresponding common trunks; 9, 9, pectoral glands, and trunks on the two sides; their efferent trunks unite with those from the axillary glands to form the subclavian lymphatic trunk; 10, lymphatic gland on the right, near the second rib, through which passes the branch from the thoracic duct to the right lymphatic trunk; 11, branch of the thoracic duct going to the right side; this right branch is a very frequent, if not a constant, feature in the rabbit; 12, 12, thoracic duct; it is frequently much more divided than is shown in this figure. The blank space near the middle indicates that a part of the length was omitted; 13, chylocyst; this is as in the dog and cat, inclined to the right side of the aorta, but it does not extend so far into the thorax; 14, intestinal lymphatic trunk; this is small, usually multiple, short, and difficult to inject with a coarse mass; 15, 16, the right and left lumbar trunks; they form a long-meshed network, and in this specimen terminate in the chylocyst by three trunks.

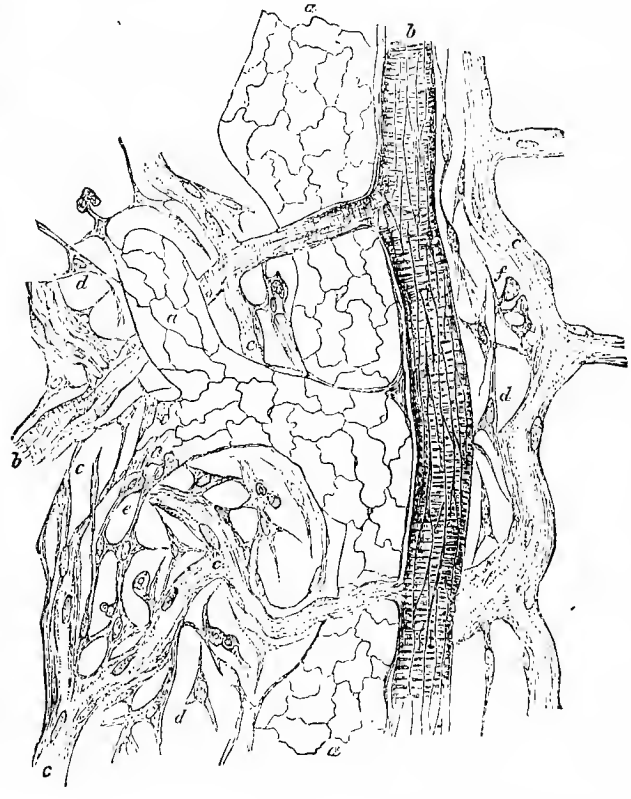


FIG. 3288.—A Penciled and Silver-stained Preparation of the Normal Omentum of a Rabbit, to Show the Relation of the Blood- and Lymph-vessels to the Tissue Cells. (Klein.) *a*, Lymphatic capillary with the outlines of its endothelial cells stained with silver; *b*, small artery showing spindle-shaped endothelial lining, and two small branches to the left; *c*, capillary blood-vessels; *d*, branched cells in the surrounding tissue; *e*, direct continuation of the endothelium of a lymph capillary with branched cells of the surrounding tissue; these cells are also attached directly to the blood capillary; *f*, wandering cells.

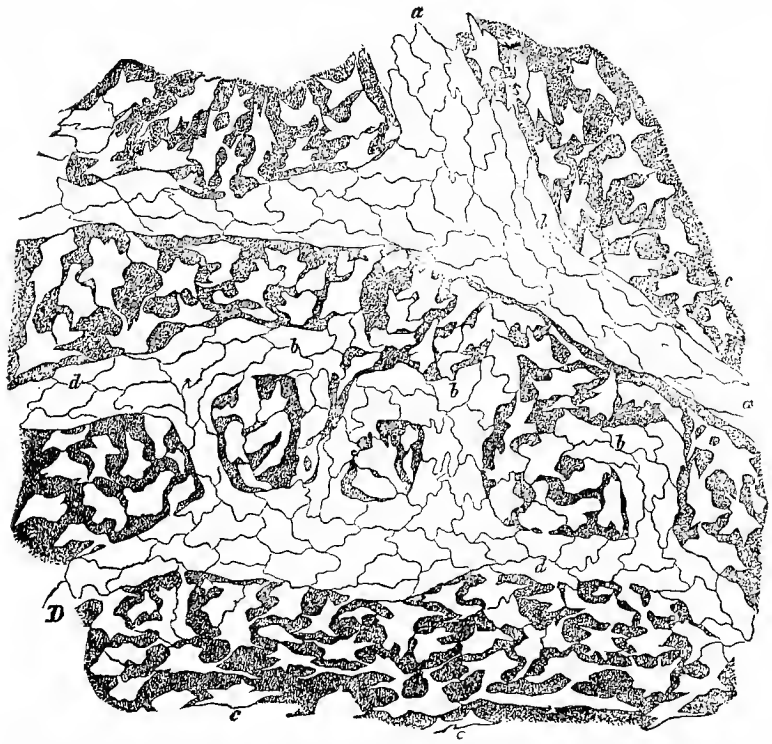


FIG. 3289.—Pencilled and Silver-stained Preparation of the Pleural Aspect of the Central Tendon of a Rabbit's Diaphragm, to show Lymphatic Capillaries and their Relation with the Cell Spaces. (Recklinghausen.*) Magnified 300 diameters. *b*, Beginning of the lymph capillaries by a continuity with the cell spaces; *c*, *c*, *c*, cell spaces surrounded by the dark ground substance. These spaces contain cells, lymph-canalicular cells, and the cell processes partly fill the white lines connecting the cell spaces (*cf.* Fig. 3288). *d*, *d*, *d*, *d*, Lymphatic capillaries with the serrated endothelial cells.

this duct terminates in the precava, and in the ox usually at the junction of the left jugular and the precava. In the ox also it usually traverses a special opening in the diaphragm. In the horse the duct is dilated at its termination, as it is also in the dog and rabbit (Figs. 3285 and 3287); in all the animals both trunks tend to open by two or more mouths (Fig. 3283), and in all the thoracic duct shows a strong tendency to conform to the lymphatics in general and break up into a kind of network instead of remaining of considerable size. Sometimes this network encloses the aorta, but more frequently it assumes the condition shown in Fig. 3283. In the rabbit almost constantly, and very frequently in the cat, there is a branch of the thoracic duct extending to the right (Figs. 3282 and 3287).

The chylocyst is large in the dog, cat, and rabbit, and in many other animals, and there is a strong tendency for its component trunks (intestinal and lumbar) to divide before entering it, so that it is formed by the union of a coarse network rather than by a few simple vessels (Figs. 3282, 3283, 3285, and 3287).

In the non-mammalia, birds, reptiles, amphibia, and fishes, the great trunks are symmetrical, that is, nearly equal on the two sides. They open into the great veins near the heart. There is also a pair of vessels opening into the ischiadic or other pelvic veins, and in the frog and toad there is a lymph heart on each great trunk, near the opening. In the non-amphibian forms, where lymph hearts are present, they are confined to the pelvic region. (See under Development, below.)

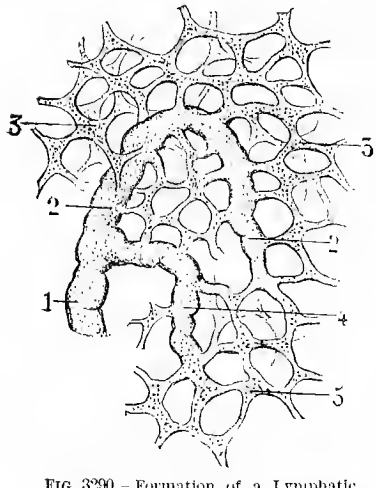


FIG. 3290.—Formation of a Lymphatic Capillary in the Skin of the External Ear. (Sappey, Atlas.) 1, Lymphatic capillary; 2 and 4, two minute branches uniting to form the larger capillary; 3, 3, 3, lacunes or dilatations formed by the union of the minutest lymphatic vessels, the capillicules. The union of a multitude of these lacunes forms a lymphatic capillary. This is shown best at the lower part of the figure.

ORIGIN AND STRUCTURE OF THE LYMPHATIC VESSELS.—There are three distinct views as to the ultimate origin of the lymphatic vessels: 1. That they are in direct communication with the blood-vessels at the periphery by means of connecting radicles so small that in normal conditions only the blood plasma can traverse them, and that under pathological conditions these connecting radicles may increase sufficiently in size to admit the passage of blood-corpuscles. This was one of the earliest views, and it is supported by the fact of the ready appearance of water or even colored gelatin in the lymphatics soon after the blood-vessels were injected. This was, and

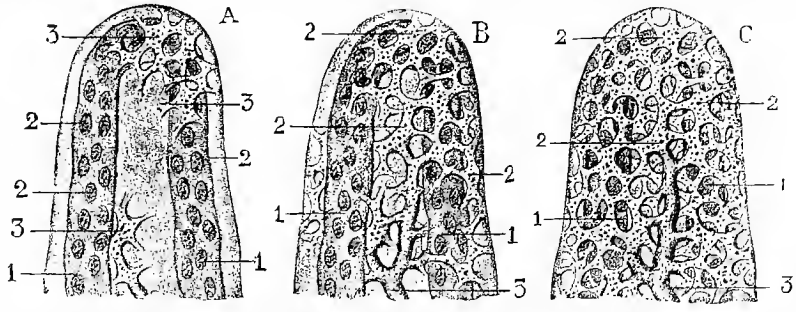


FIG. 3291.—A Simple Papilla from the Corium of the Hairy Skin of the Head, showing the Blood-vessels and Three Stages of Lymphatic Injection. (Sappey, Atlas.) *A*, A papilla, the simple blood-capillary loop (1 and 2) with very few lymphatic lacunes (3) and no sign of a lymphatic capillary. *B*, The lymphatic capillary (3) has appeared, and the lymphatic lacunes and capillicules (2) are very prominent, but the blood-capillary loop (1) is still evident. *C*, The blood-capillary loop (1) is almost invisible from the dense network of lymphatic lacunes and capillicules (2); the lymphatic capillary (3) is prominent. This series is an excellent illustration of the structures that remain invisible in ordinary preparations. Probably in very few histological preparations are more than half or one-third of the structures seen.

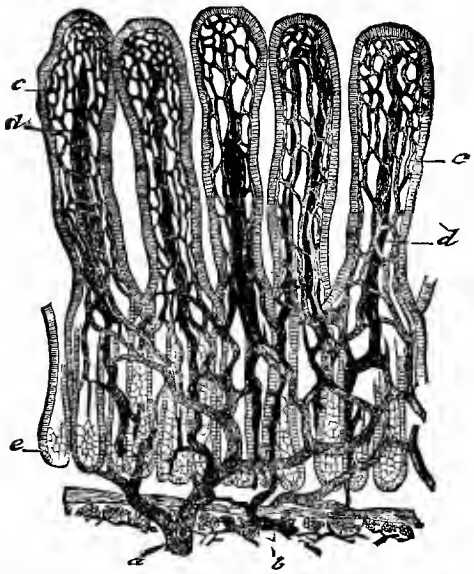


FIG. 3292.—Lacteals of the Intestinal Villi of the Dog. (Cadiat.) *a*, Artery extending into the villi to form a capillary network (light shading); *b*, lacteal extending from the villi into the submucosa (dark shading); *c*, *c*, blood capillaries in the villi; *d*, *d*, central lacteal of the villi. In one it forms a loop, in the others it ends blindly; *e*, crypts of Lieberkühn.

still is, a favorite method of demonstrating the lymphatics of an organ. In objection to the doctrine of the direct connection of the two systems of vessels, it was

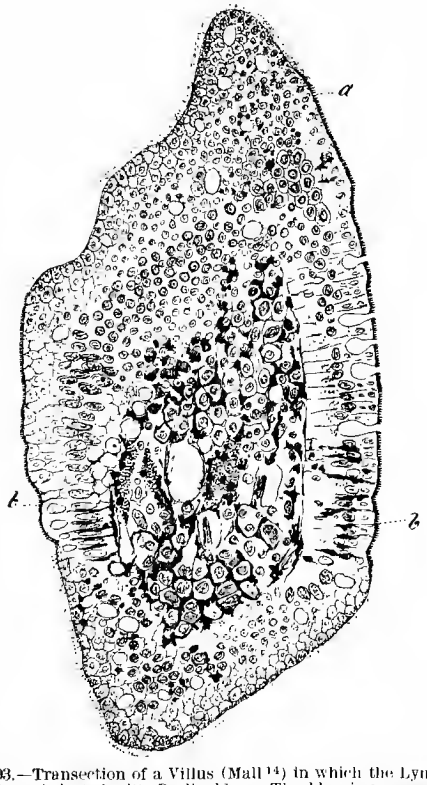


FIG. 3293.—Transection of a Villus (Mall [14]) in which the Lymphatics have been injected with Berlin blue. The blue is represented by black in the figure. From the centre fine streams of the injecting mass have penetrated to the epithelium and even between the epithelial cells. *a*, sectional view of the epithelial cells with the lymph channels in section; *b*, *b*, longisections of the epithelial cells showing the lymph channels between them.

pointed out by Hunter that, when the coarser matters injected into the blood-vessels appeared in the lymphatics, it was due to a breakage somewhere in the wall of the blood-vessel; and further, that the filling of the lymphatics by injecting water or gelatin into the blood-ves-

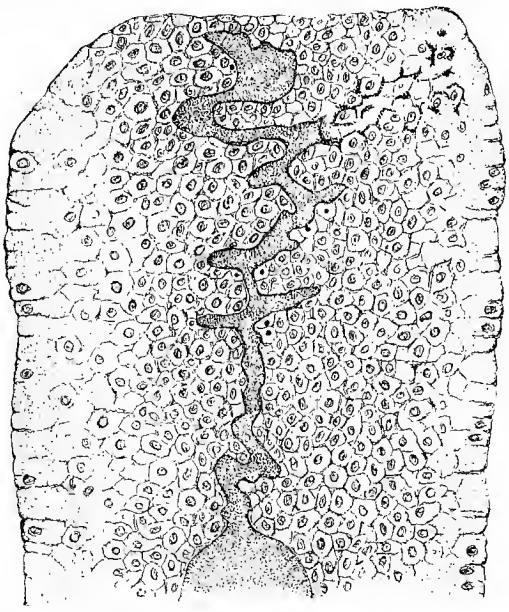


FIG. 3294.—Longisection of the Terminal Part of a Villus (Mall [14]) to show the narrow, spiral extension of the central lacteal, with fine branches reaching out from it toward the surface. The epithelium has been removed and the lymphatics have been injected with Berlin blue (cf. Plate XLIV. and Fig. 3293).

sels was but natural, as it is one of the properties of the blood-vessels to allow the contents to diffuse through their walls, and the lymphatics, from their office as a drainage system, take up the exuded liquid. This does

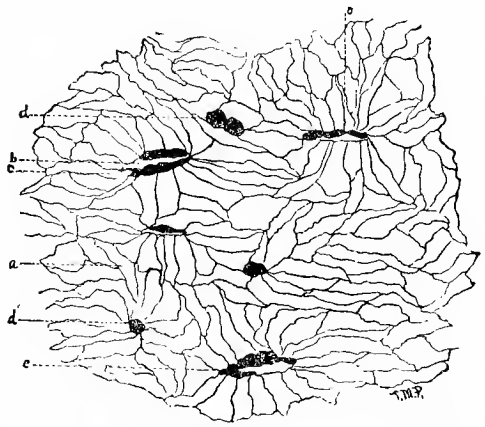


FIG. 3295.—Portion of the Cisterna Lymphatica Magna of the Frog, to show Endothelium and Stomata. (Prudden.) *a*, Ordinary endothelial cells, the nuclei not being shown; *b*, *b*, stomata leading from the peritoneal cavity into the dorsal lymph sac; *c*, *c*, germinating endothelium surrounding the stomata; *d*, germinating endothelia among the ordinary cells; these are frequently called pseudostomata.

not, however, show how the exuded liquid gets into the lymphatics. The pressure which forces the plasma through the walls of the blood-vessels would seem rather to collapse the lymphatics, as the pressure is on the outside. In a word, there has been no conclusive proof

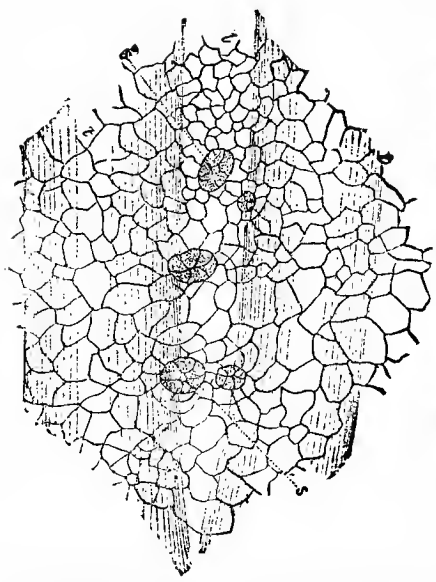


FIG. 3296.—Silver-stained Peritoneal Aspect of the Central Tendon of a Rabbit's Diaphragm, to show Stomata. (Klein.[7]) *l*, Lymph channel between the tendon bundles; *s*, *s*, five stomata, surrounded by germinating endothelium and leading into the lymph channel between the two tendinous bundles. Part of the stomata are open and part closed; *t*, *t*, two bundles of the central tendon, between which is the lymph channel into which the stomata open. Over the tendinous bundles the endothelial covering is composed of markedly larger cells than over the lymph channel.

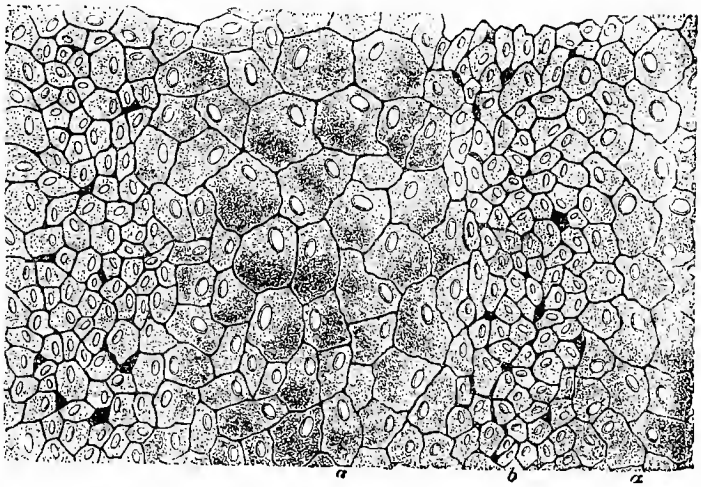


FIG. 3297.—Peritoneal Endothelium from the Central Tendon of the Rabbit's Diaphragm, to show the Difference in the Size of the Cells, and the Pseudostomata between them. (Klein.) *a*, *a*, Irregular rows of large nucleated endothelial cells, corresponding to underlying tendinous bundles; *b*, rows of smaller endothelial cells with numerous pseudostomata between them (the dark spots). The rows of small cells correspond to the lymph channels between the bundles (cf. Fig. 3296).

given that there is or is not a direct connection between blood-vessels and lymphatics.

2. That there is a network of minute spaces in the tissues between and around the individual structural elements, through which the diffused plasma slowly moves, bathing all the cells and fibres, giving to them oxygen and the other nutritive elements, and taking in return carbon dioxide and the other products of waste. Part of this waste, especially the carbon dioxide, diffuses back into the blood capillaries. This system has been called *juice spaces and canals* by Recklinghausen[8] and the *lymph-canalicular system* by Klein.[7] These minute channels and spaces are all interconnected and continuous with the

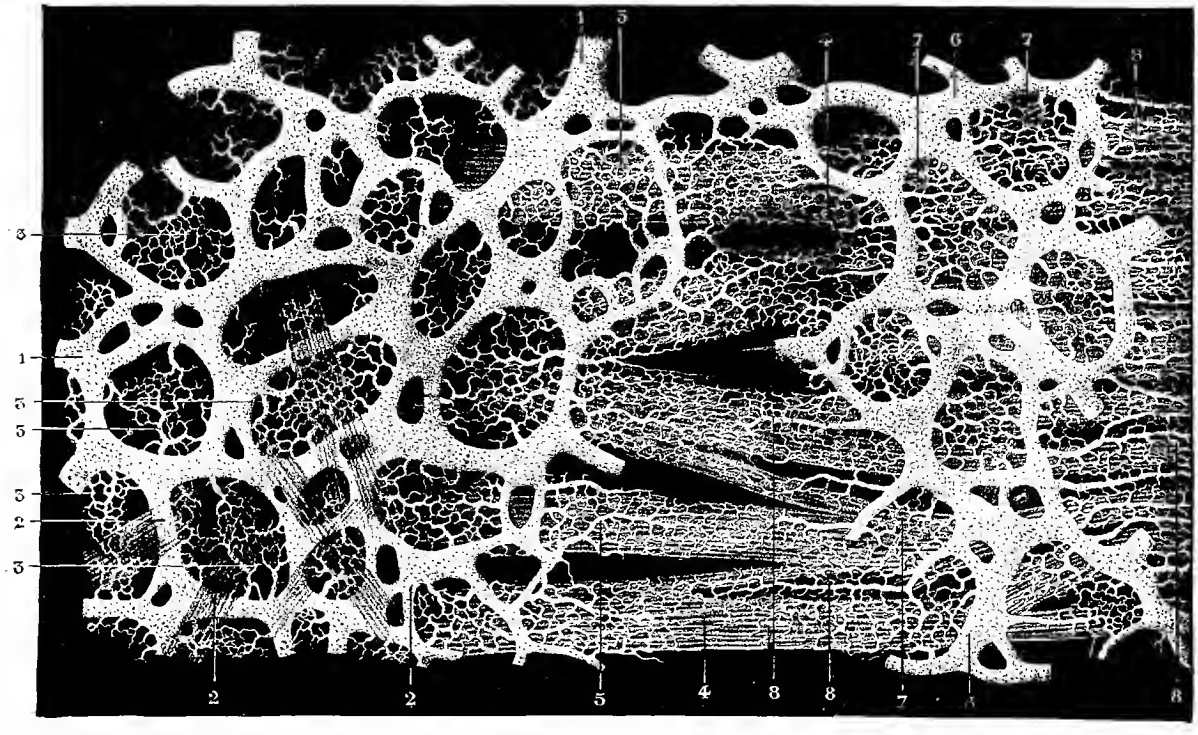


FIG. 3298.—Finer and Coarser Lymphatic Network of the Muscularis of the Small Intestine of a Child at Birth. (Sappey, Atlas.) Magnified 200 diameters and reduced about one-third. 1, 2, and 6, Coarse network of lymphatics resting upon the longitudinal muscles; 3, 4, 5, 7, and 8, finest lymphatic network around the muscular fibres, and uniting to form the larger network.

blood-vascular system through the intercellular cement and spaces, and with the lymphatic vessels in the same way, and further, these spaces frequently, if not constantly, contain branched cells, the cell body filling the larger spaces and the processes the connecting channels. These cell processes are often projected between the endothelial lining of the capillaries, thus forming the so-called pseudostomata, and therefore bring the lymphatics and blood-vessels really into continuity by the intervening cells and the spaces surrounding them. This is well shown at *e*, in Fig. 3288.

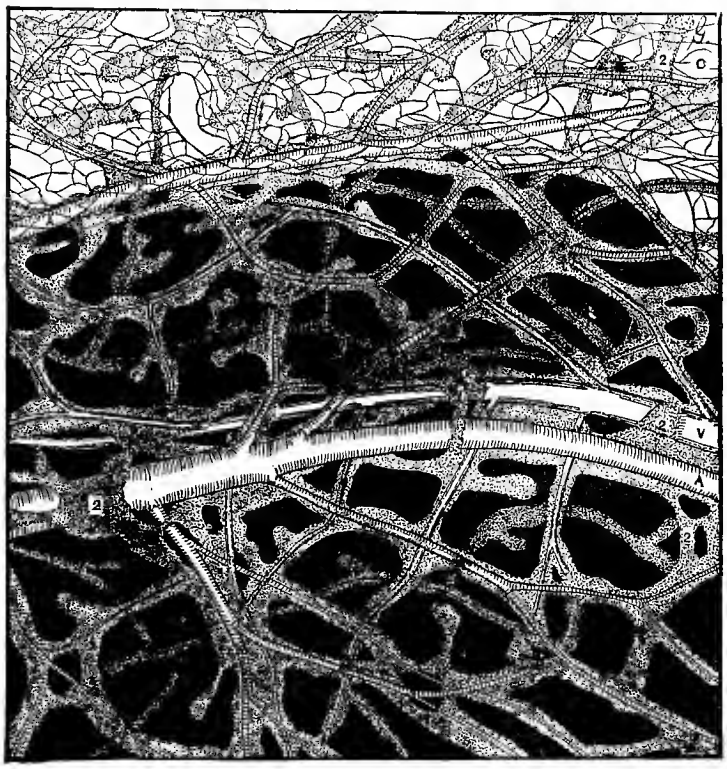


FIG. 3299. Surface View of the Lymphatic Network in the Submucosa of the Rabbit's Cæcum, showing the Form of the Network and the Relation of the Lymphatics and Blood-vessels. Magnified 55 diameters. (Drawn by Mrs. Gage.) *A*, *A*, Small arteries; *V*, small vein; *C*, the blood capillaries in the upper part of the figure; 2, 2, 2, 2, lymphatic vessels. (cf. Fig. 3300.) Throughout the entire figure is shown the tendency of the lymphatics to follow the blood-vessels and partly to surround them. The preparation was made by injecting Hoyer's chrome yellow mass into the appendix vermiformis, when it extended into the submucosa of the adjoining part of the cæcum (see Fig. 3286). The blood-vessels were then injected with fine red gelatin mass from the superior mesenteric artery. After the gelatin had cooled the cæcum was distended with alcohol, and the preparation finally mounted in Canada balsam.

3. The third view is that of Sappey, who has represented with marvellous clearness the entire lymphatic system from origin to termination. He believes, and thinks he has proved by new and special means of research, that the lymphatic system at its origin is invariably composed of minute vessels (capillicules) from 1 μ to 4 μ in diameter, with structureless walls, which extend around and between all the structural elements. These capillicules are closed at the free end, but join, in nearly the same way as do the canaliculi of bone, to form somewhat larger spaces, the lacunes, which vary from 2 μ to 8 μ in diameter, and like the capillicules have structureless walls. By the union of many lacunes the true lymphatic capillaries are formed, and in them first appears the endothelial lining. Further, although the capillicules around and between the structural elements have blind terminations, those connected with the blood-vessels extend into the lumen between the endothelial cells, and have open mouths into which the plasma of the blood can freely enter, and in some pathological conditions they may become so large that the blood corpuscles may pass through the capillicules to the lymphatic vessels. This view is in part a return to the original doctrine, and it also differs from the doctrine of the lymph-canalicular origin in excluding the cells from the spaces or lacunes, and in giving distinct but structureless walls to the capillicules and lacunes.

The second view seems to the writer to be more in accordance with the teachings of modern biology and histology, by which the body is shown to be composed of a continuous network of interconnected structural elements independent only in the form of blood corpuscles, lymph, and wandering cells, but all the other elements being united either by cell cement or by delicate protoplasmic processes, and any spaces left between the structural elements being filled by the product of cell activity, which is known as ground or intercellular substance. This is very abundant in some tissues, as cartilage, very slight in amount in others, as epithelia. All of these structural elements are constantly bathed with lymph, and it is more in accord with what is at present known of absorption and excretion (see articles *Absorption*, *Digestion*, and *Metabolism*) to suppose that the lymph depends for its movement in certain definite directions upon the action of the living cells rather than on merely physical conditions. From the latest and most satisfactory work on the development of the lymphatics (see below) it would appear that the lymphatic system is a closed one, and all passage of lymph to it from the tissues or vice versa, must take place by diffusion as with the blood-vascular system.

The readily demonstrated or apparent origin of the

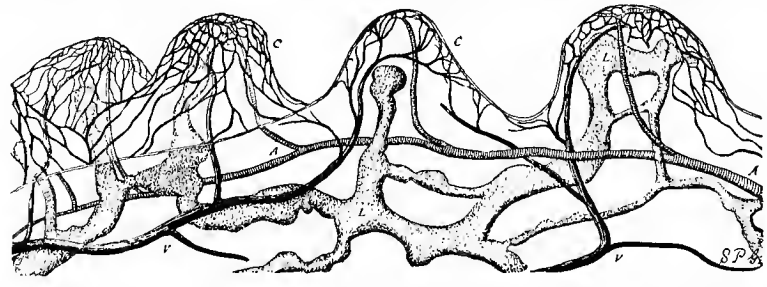


FIG. 3300.—Side View of the Lymphatics and Blood-vessels in the Cæcum of the Rabbit. (Drawn by Mrs. Gage.) *A*, *A*, artery; *V*, *V*, veins; *L*, *L*, lymphatics; *C*, villi. This figure shows the villus-like elevations persisting in the cæcum of the rabbit (Hilton [12]) with the vascular and lymph vessels. It will be noted that the artery for each villus extends to the summit and breaks up a network of capillaries which form a kind of mantle or tent. The lymphatics show the usual appearance, but with a kind of network in the villus at the right. On the left the whole villus is present at the top; on the right the part toward the observer has been removed from the two villi.

lymphatic vessels is in a plexiform network of valveless capillaries of varying sizes (Plates XLII., XLIII., and XLIV., and Figs. 3298 and 3299). From this capillary network extend collecting trunks with abundant valves (Fig. 3267). The serous cavities are likewise directly connected with the lymphatic vessels through the stomata or pseudostomata (Figs. 3295–3297). But the pleuro-peritoneal cavities are not primarily connected with the lymphatic system, but come to be so connected later.

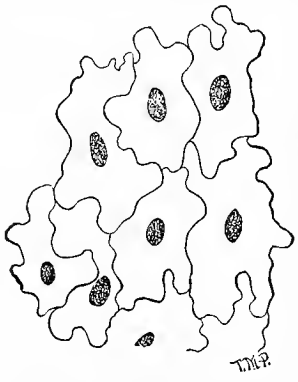


FIG. 3301.—Endothelial Cells from a Small Lymphatic Capillary of the Central Tendon of the Rabbit. This figure shows well the characteristic sinuous outlines and the nuclei of the endothelial cells. (Prudden.)

A distinct plexus of origin has been satisfactorily demonstrated in all the tissues and organs except the following, and in some of these, as the cornea, the lymph is known to circulate, although not in an independent network of vessels.

1. The central and peripheral nervous system and retina. The lymph in these situations is either in perivascular spaces or in perineural spaces. In the optic nerve, however, Key and Retzius figure a well-defined lymphatic network.

2. A lymphatic network has not been satisfactorily made out for bone or cartilage, and Sappey denies the presence of lymphatic vessels in these structures.

3. All forms of epithelia, including hair, nails, and teeth. But Klein figures and describes processes of branched cells projecting between epithelial cells and serving as lymph channels; but no distinct capillaries with endothelial walls are present. (See also Mall,[14] and Fig. 3293.)

4. Cornea and, according to Sappey, all forms of fibrous tissue, tendons, aponeurosis, fascia, and all serous membranes. Where a plexus of origin appears to be in these it belongs to the underlying tissue. According to many authors the connective tissue is a favorite place for the origin of the capillary lymphatic networks. There is no doubt of the presence of the network, the only question is whether it belongs to the connective tissue or to the surrounding tissues.

The ducts of some glands (as the pancreas) have never yet been shown to contain lymphatics, although in the ducts of other glands, as the liver, lymphatics have been shown in great numbers.

These networks or plexuses of origin show considerable variety in different parts of the body. As a rule, the lymph capillaries are considerably larger than the blood capillaries (Figs. 3299, 3300), and there is a great tendency to form blind, often ampulliform enlargements (Fig. 3300). In the villi of elongated narrow form, the origin by a blind central vessel is normal, or there may be a simple loop instead (Fig. 3294). In man, where the villi are mostly short and broad, there is a complicated network something like the blood capillaries, except that the lacteal capillaries are much larger. The simple blind end and loop are also seen in some of the more elongated villi. The presence of ampulliform enlargements, or even blind endings, in a vessel is not enough to determine whether it is a blood-vessel or a lymphatic, for some blood-vessels in muscle (Ranvier) and in the dura of the brain (Key and Retzius) have the form which is usually considered so characteristic of lymphatic vessels. The final test must be the connections of the vessel with a lymphatic gland or with an undoubted blood-vessel.

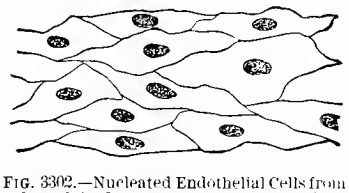


FIG. 3302.—Nucleated Endothelial Cells from One of the Larger Lymph Channels of the Central Tendon of the Rabbit's Diaphragm, to show the Elongated Form of the Cells in the Larger Vessels. Cf. Fig. 3301. (Prudden.)

Structure of Lymphatic Vessels.—Beginning with the lymph capillaries the wall is composed only of endothelial cells arranged mostly in the form of a tube. They may, however, be more like flattened clefts, the walls of which are in apposition except when containing lymph. The lining cells have sinuous edges (Fig. 3301). On the larger vessels the lining endothelium has more elongated cell outlines (Fig. 3302), and there progressively appear coats like those of the blood-vessels, except that they are thinner. The adventitia is easily separated from the vessel, is composed of a network of fine elastic fibres and a few longitudinally arranged muscular fibre cells. The middle coat has, besides the fine elastic tissue, many circularly arranged muscular fibre cells. This circular arrangement is not strictly adhered to, especially in the thoracic duct. Finally, the inner layer has its elastic fibres mostly in a longitudinal direction, and the endothelium covers the ental surface. In the thoracic duct there is usually a considerable addition of white fibrous tissue to the middle layer, and, as stated above, many of the muscular fibres of this layer may be oblique or even longitudinal. In general, then, the lymphatic vessels agree with the veins quite closely in structure. The amount and the fineness of the elastic tissue present is supposed to exert a marked influence in causing the speedy return of the vessel to its normal calibre after its distention by the lymph.

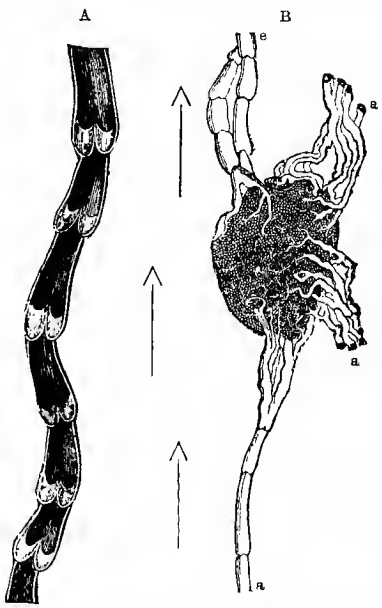


FIG. 3303.—Valves of a Lymphatic Trunk, and a Lymphatic Gland with its Afferent and Efferent Vessels. (Sappey.) *A*, Lymphatic trunk slit lengthwise and opened to show that the valves are in pairs—they are close together and they are at the level of the enlargements; further, that the intervalvular segments are in general of a conical shape, the apex of the cone pointing in the direction of the current, up in this figure. *B*, Lymphatic gland; *a*, *a*, *a*, the numerous afferent lymphatic vessels; *e*, the two voluminous efferent lymphatics.

Like the veins, the lymphatics are distinguished by the presence of valves; but they are much more abundant, there being, for example, sixty to eighty double valves from the hand to the axilla (Fig. 3303). In examining a well-injected preparation, it is very easy to determine the direction of the lymph stream as the segments of the vessel are approximately conical, the apex of the cone pointing in the direction of the stream (Fig. 3303). This is more marked in the smaller than in the larger vessels.

Valves are not found in the lymphatics of fishes, and are much less numerous in the other groups than in mammals.

Lymphatic Glands or Nodes and Lymphoid Tissue.—The lymphatic glands or ganglia or conglobate glands are rounded or flattened bodies placed in the course of the lymphatic vessels. These glands were known to Hippocrates, but were regarded by him as forming a part of the general glandular system. Naturally their true nature was discovered only after the discovery of the lymphatic vessels. In the higher mammals it is believed that no lymphatic vessel reaches one of the common terminal trunks without first traversing one or more of these glands. They first appear in the birds, or perhaps some of the highest reptiles, but lymphoid tissue is present in all the forms; and as the glands are practically concentrations of this lymphoid tissue their absence is not so important as might at first appear. The glands are sometimes solitary but usually are in groups or chains; they are mostly near blood-vessels, and so placed and loosely attached that they readily move aside to avoid pressure. In the limbs pressure is further avoided by position in the flexures of the joints. The glands vary greatly in number and size in the different mammals. In man they reach the highest number (five hundred to six hundred) and vary from a few millimetres to two or more centimetres in diameter.

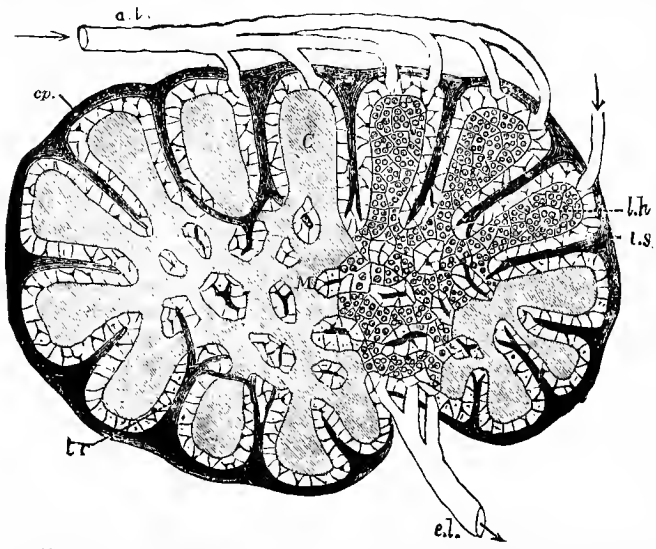


Fig. 3304.—Diagrammatic Section of a Lymphatic Gland. (Sharpey.) *a, l*, Afferent trunk breaking up into several smaller trunks before entering the gland; *e, l*, efferent lymphatic trunk formed by the union of several smaller trunks emerging from the gland (the arrows indicate the direction of the current); *C*, cortical glandular substance; *cp.*, capsule sending septa into the gland; *l.h.*, reticulated cords of medullary substance (it is shown in only a small part of the figure; the entire area shaded with lines possesses similar glandular substance); *l.s.*, lymph sinus or channel; *M*, central or medullary part of the gland (it is directly continuous with the cortical substance); *tr.*, trabeculæ or fibrous substance continuous with the capsule and forming a coarse meshwork in the gland (in this mesh is the proper gland substance).

Afferent and Efferent Vessels.—The vessel approaching a gland is said to be afferent or inferrent; the one leaving the gland is called efferent. On approaching a gland the afferent usually breaks up into several smaller vessels which enter the gland (Figs. 3303 and 3304). After traversing the gland the vessels leaving the surface unite usually in larger trunks than the afferent vessels, and continue to the next gland, where the process is repeated, or the vessel may terminate in one of the common trunks.

The structure of the lymphatic glands was long enigmatical. It was held by many, and is still so held, that the gland was really a kind of fine capillary network, like a renal glomerulus, or a rete mirabile, of blood-vessels; but it is now quite generally agreed that a lymphatic gland consists of the following parts: (1) A fibrous framework forming an enclosing capsule and sending into the interior a multitude of anastomosing trabeculæ. The capsule and larger trabeculæ may also contain muscular-fibre cells. (2) Embedded in the meshes of this fibrous network is the proper glandular substance, which consists of lymphoid tissue; that is, a fine network of branching and anastomosing cells and fibres containing in their meshes lymphoid corpuscles or young lymph cells. Near the surface of the gland the lymphoid tissue is arranged in quite regular masses (cortical lobes or avcoli) by the projecting trabeculæ (Fig. 3304). This is the so-called cortical portion, while in the central part (medullary portion) the lymphoid tissue is in more cylindrical masses (the medullary cylinders or lymphoid cords), but the tissue in the two parts is directly continuous. (3) The lymph sinus or channel. This is the path taken by the lymph in passing through the gland from the afferent to the efferent vessels. It is a narrow space filled with rather coarse retiform tissue, between the proper glandular substance and the fibrous framework (Fig. 3304, *l.s.*). The relations of this space may be clearly understood by comparing the fibrous framework to a mould and the proper glandular substance to the material poured into the mould and which, upon cooling, had shrunken evenly from the mould throughout the entire gland, thus leaving a narrow space which would represent the lymph channel. The afferent lymph vessel penetrates the sheath or capsule of the gland and pours its contents into the lymph sinus. The lymph then slowly

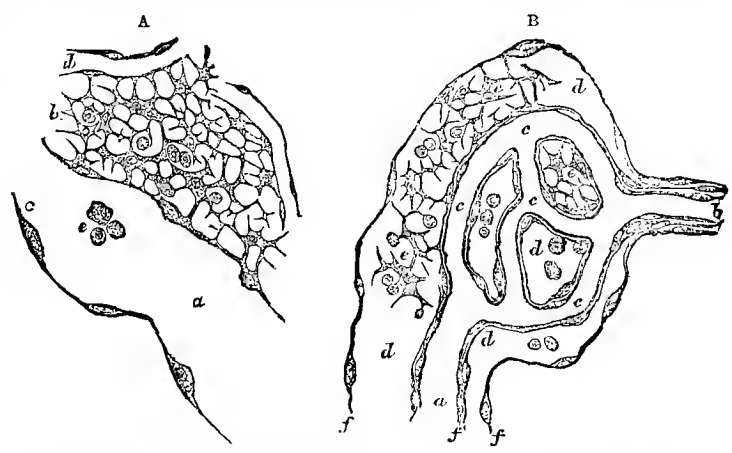


Fig. 3305.—Figures of Fresh Preparations of an Œdematous Omentum of a Guinea-pig suffering from Chronic Peritonitis, to Show Developing Lymphatic Nodules seen in Optical Section. (Klein.[7]) *A*, Perilymphatic or lymphangial nodule; *a*, lymphatic vessel; *b*, a portion of the lymphangeal nodule on the side of the vessel; *c*, endothelial wall of the lymphatic seen in profile; *d*, blood capillary of the nodule; *e*, lymph corpuscles in the lymphatic vessel (this nodule is like the reticular substance forming the proper glandular substance of the lymphatic glands, and as seen both in *A* and *B* the cells of the reticulum are in direct connection with the endothelium of the lymphatic vessel). *B*, An endolymphatic or lymphangial nodule in which the reticular tissue is within instead of being on the side of the vessel; *a*, vein; *b*, artery; *c*, blood capillaries; *d*, a lymphatic vessel enclosing the whole system of blood-vessels; *e*, reticulum of nucleated branched cells or lymphoid tissue connected with the wall of the lymphatic and filling the entire lumen.

moves along the labyrinthine channels until it reaches the efferent vessels, when it enters them and continues toward the common lymph trunk. In passing through the sinus the lymph bathes the glandular substance and probably soaks into it. Along the edge of the channel the newly developed lymph cells enter the lymph stream and are carried along to the efferent vessel.

Blood-vessels are very abundant in the lymphatic glands and are found almost exclusively in the proper glandular substance. These blood-vessels are also accompanied by nerves. In some glands the efferent vessels and the blood-vessels are found mostly in a small depression which, in analogy with the kidney, has been called the hilus. This is not a marked feature and is absent in many cases.

In infancy and youth the glands near the surface are grayish in color while those in the interior of the body are pinkish. In adult and advanced life the glands are usually somewhat atrophied and darker in color, and those of the bronchial plexus are often dark brown or even black.

Lymphoid or adenoid tissue is like that described for the proper glandular substance of the lymphatic glands; that is, a fine network of branching and anastomosing cells or fibres with the meshes crowded with lymphoid cells. Sometimes this tissue is quite sharply defined, when it is called a follicle or simple lymphatic gland; in other situations it is diffuse. The tissue is abundantly supplied with blood-vessels, and the lymphatic vessels on its surface and emerging from the interior are in great abundance (Fig. 3306). The diffuse and follicular form of the tissue is found in great abundance in the alimentary canal of man and the lower animals. In the tonsils and the pharyngeal tonsil it is aggregated in considerable masses; so also in the Peyerian patches, which are simply an aggregation of lymph nodules, follicles, or solitary glands. The mucosa of the vermiform appendix of the rabbit (Fig. 3286) is almost entirely occupied by a great Peyer's patch; and the so-called solitary glands (Fig. 3306) are lymphoid nodules or follicles with a dense meshwork pervaded by blood capillaries and filled with lymph corpuscles. They are surrounded by a capillary network which helps to separate them somewhat from the surrounding less condensed lymphoid tissue (Fig. 3306).

Hæmolymph Glands.—Deep red or chocolate-colored bodies from 1 to 20 mm. in diameter with the general structure of lymph glands but with the sinuses filled with blood instead of lymph.

In structure the parenchyma of these glands resembles spleen or red marrow (splenolymph or marrow-lymph glands). The glands resembling spleen are most common. Intermediate or transition forms between hæmolymph glands and the ordinary lymph glands occur.

Hæmolymph glands have been reported in the following animals: Hen, turkey, rat, dog, sheep, goat, ox, pig, horse, and in man. They occur most frequently along the great blood-vessels, especially those of the abdomen. They are most easily found in the root of the mesentery, and in the neighborhood of the renal and adrenal vessels. In the cervical region they are commonly near the parathyroids (Warthin [9] and Vol. IV. of this Handbook).

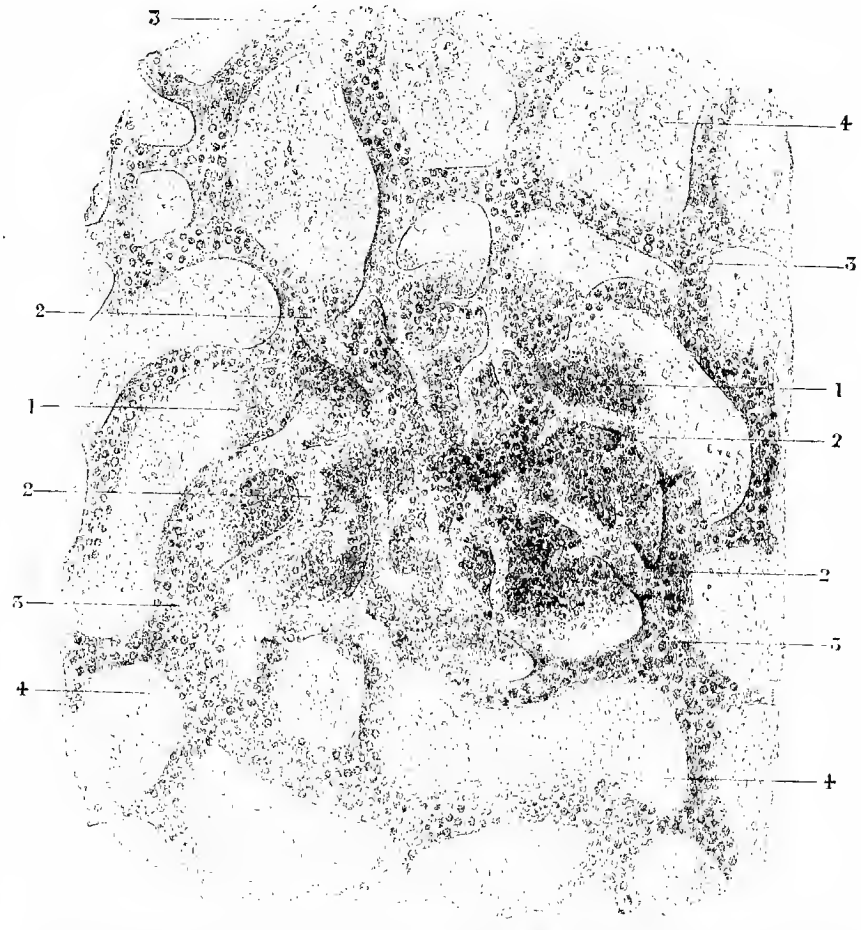


FIG. 3306.—Lymphatic Vessels arising from a Lymph Follicle or Solitary Gland of the Large Intestine of Man. (Sappey, Atlas.) Magnified 100 diameters and reduced about one-fourth. 1, Lymph follicle seen from the submucosa; 2, 2, 2, 2, lymphatic radicles arising in the depth of the follicle and appearing on the surface; 3, 3, 3, trunklets formed by the union of the smallest radicles; 4, 4, base of the crypts of Lieberkühn.

DEVELOPMENT OF THE LYMPHATIC SYSTEM.—While in the past much serious study has been given to the development of the lymphatic system in the embryo, the matter has remained in a very unsatisfactory condition until recently. From the time when this system was discovered and worked out, in the adult it has been known that it is an appendage of the venous system. It has also been known for many years that the lymphatic system develops considerably later than the blood-vascular system. However, it is only within the present year (1902) that it has been shown conclusively that this system does not grow in from the exterior part of the body and finally form a union with the veins, *but on the other hand that it is a direct outgrowth of the venous system* (Sabin [10]).

As worked out for the pig it was found that the lymphatic system is at first symmetrical and grows out from the veins at four points, that is at the junction of the veins of the limbs with the cardinal veins, viz., at the junction of the subclavian and precardinal veins in the base of the neck, and in the lumbar region at the junction of the sciatic and femoral veins with the post-cardinals. Slightly beyond its origin from the vein each of the four original lymph trunks or ducts dilates to form a lymph sac or lymph heart. In lower forms, as the frog, lymph hearts contain striated muscle and are rhythmically contractile; it has not yet been shown, however, whether these sacs in the developing mammal are contractile or not.

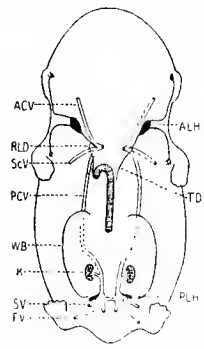


FIG. 3307.—Diagram of the Lymphatic System of an Embryo Pig 20 Mm. Long. × 2. (Sabin.) *ACV*, Precardinal vein; *RLD*, right lymphatic duct; *ScV*, subclavian vein; *PCV*, post-cardinal vein; *WB*, Wolffian body; *K*, kidney; *SV*, sciatic vein; *FV*, femoral vein; *ALH*, anterior lymph sac or lymph heart; *TD*, thoracic duct; *PLH*, posterior lymph sac or lymph heart. It is to be noted that the lymphatic system is symmetrical, but that in the cephalic part of the body it is considerably more advanced than in the caudal half.

As demonstrated in the following figures the lymphatics develop first in the cephalic half of the body; the system is symmetrical, but soon the left side preponderates; the connection of the lymphatics with the veins in the caudal half of the body is soon lost; there are very early two chylocysts, and two thoracic ducts, but as both thoracic ducts grow down to join the lumbar ducts from the left side, the asymmetry of the lymph trunks in the cephalic half of mammals is original and not secondary. It is also seen that the lymphatics as they grow out to the periphery are in a close-meshed network, the ends of the tubes forming the network ending blindly, and extending farther and farther over the body by a continual sprouting of the tubes.

The lymphatic glands are developed from a network of lymph vessels by an ingrowth of lymphoid tissue and by the formation of a connective-tissue capsule around the outside. Finally it should be stated that beginning with Kölliker in 1879 an increasing number of embryologists have come to believe that the real origin of the lymph corpuscles of the body is from the epithelial cells of the thymus (Beard[11]).

Methods. — The lymphatic vessels are so thin that unless they contain some liquid or solid they are not visible. One of the first ways of making the general lymphatics visible was to inject water or colored gelatin into the arteries of an organ. The mass exudes and fills the lymph vessels; this is especially successful if the vein is tied. The lacteals are made evident by feeding the animal some fatty food, like milk, an hour or two before death.

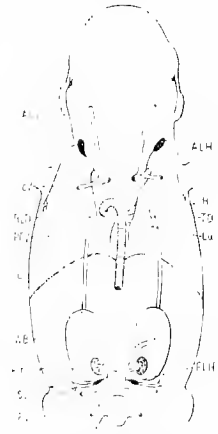


FIG. 3308.—Diagram of the Lymphatic System in an Embryo Pig 27 Mm. Long. × 2. (Sabin.) *D*, Diaphragm; *H*, duct to the heart; *Lu*, duct to the lungs. The other letters as in the previous figure. In this figure it is seen that the lymphatics in the cephalic half are more advanced on the left than on the right.

Vessels of sufficient size may be injected centrad with starch or plaster-of-Paris. It is not necessary to tie the cannula in place; simply pressing upon it with the fingers is sufficient. The insertion of the cannula is greatly facilitated by first inserting a beaded bristle into the lymphatic, then by raising the bristle the cut in the vessel may be seen. Where the vessels are too small to be seen, very successful injections may be made by the puncture method. That is, a hypodermic cannula is connected with a syringe or a constant-pressure apparatus, and inserted where lymphatics are supposed to be. The cannula is forced in as in ordinary hypodermic injections, and the mass allowed to flow or it is forced in. If the attempt is successful, the fine network and collecting trunks of a limited area will be injected. The toes and the finger-tips of man are favorite places for injection. In animals the pads of the feet and the bare spot on the snout are good. A lymphatic gland is always easy to inject. For an injecting mass mercury was much used by the older anatomists. Colored gelatin was also used and is now much more employed than mercury as it flows readily through the lymph glands. An excellent gelatin mass is Hoyer's chrome yellow; dry gelatin, 15 gm.; water, 75 c.c. After the gelatin is softened it is melted over a water-bath and heated to 80° C., then 75 c.c. of a cold saturated solution of bichromate of potash, heated to 80° C., is added to the gelatin; finally, 75 c.c. of a cold saturated solution of acetate of lead is heated to 80° C. and added with constant stirring. Berlin blue in gelatin is preferable for microscopic specimens (Plate XLIV. and Figs. 3293, 3300). India ink in water is also of great service, especially in embryos.[10]

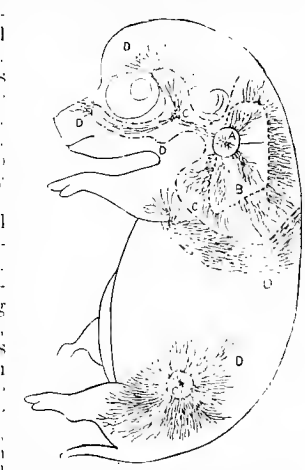


FIG. 3309.—Diagram of the Lymphatic System in the Embryo Pig 30 Mm. Long. × 2. (Sabin.) *MP*, Mesenteric plexus; *RE*, receptaculum chyli (chylocyst). The other letters as in Fig. 3307. It will be seen that in this figure the chylocyst is double, and that the thoracic duct is also double nearly to its termination. In this stage the caudal lymph sacs have lost their connection with the vein, and from now on the only connection with the vascular system is through the thoracic duct as in the adult.

The puncture method was used by Hunter, Mascagni, and Cruikshank. Cruikshank, in his "Anatomy of the Absorbing Vessels" (1790), p. 44, says: "I have sometimes injected the lacteals from punctures made by the side of the veins where I knew they must be, though they were then invisible to the naked eye." He also injected the lymphatic glands by puncture.

Young animals are best for studying the lymphatics, and the leaner the animal the better. For investigating the embryology of the lymphatics, embryos in which the heart is still beating are best. After the embryos are cold they cannot be satisfactorily injected (Sabin[10]). In man lymphatics have been demonstrated in organs in

FIG. 3310. — Composite Picture of the Spreading of the Superficial Lymphatics in the Embryo Pig. (Sabin.) *A*, Area of lymphatics in a pig 18 mm. long; *B*, area in a pig 20 mm.; *C*, area in a pig 30 mm. long, *D*, area in a pig of 40 mm. long. In the stages shown there are no lymphatics beyond the outlines indicated.

the fœtus when they could not be in the adult. Mature animals are better for the lymphatics of the reproductive

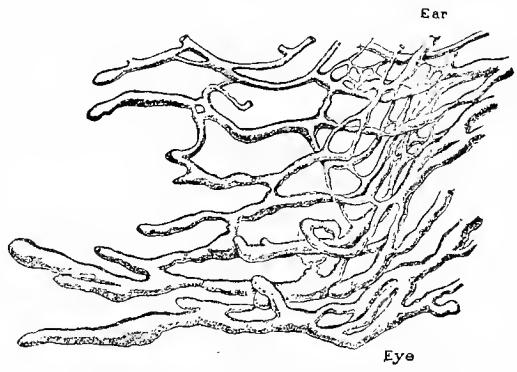


Fig. 3311.—Terminal Lymphatics of the Skin Between the Eye and Ear in a Pig 50 Mm. Long. × 11. (Sabin.)

organs, and, for the pancreas, an old man or animal is to be chosen. *Simon Henry Gage.*

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The writer wishes to express his great indebtedness to Professor Wilder for generous supplies of material for investigations in the comparative anatomy of the lymphatic system, for aid in purchasing costly works, and for hearty encouragement; to the library of the Surgeon-General's Office for the loan of rare and valuable works of reference, and, finally, to the editor for encouragement and suggestions.

In preparing the article free use has been made of the larger works on physiology: Flint's treatise, Landois and Stirling; Milne-Edwards, Leçons, etc. In human anatomy, Allen, Gray, and Quain in English; Sappey in French; Henle, Krause, Gegenbaur, and Hoffmann in German. The clinical remarks are especially complete and satisfactory in Allen; many very suggestive remarks are also made in Sappey's Atlas. In comparative anatomy the works of Owen, Gegenbaur, and Parker's translation of Wiedersheim, in English, and Milne-Edwards' Leçons, in French, are the most satisfactory. For the bibliography of the subject Mascagni, Milne-Edwards, Hoffmann, and Robin (see [5] below) are especially commendable, as is also the Index Catalogue of the Surgeon-General's library. Specific references have been made to the following:

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LYMPH NODES, DISEASES OF.—Anatomical Considerations.—The proper appreciation of the pathological changes met with in the lymph nodes presumes a slight knowledge of the normal anatomy of these organs. They are small, bean-shaped or oval nodules which lie in the course of the lymphatic vessels and on the more protected portions of the body, as, for example, in the lateral regions of the neck, the axillæ, the inguinal regions, about the peritoneal and pleural cavities, and in the folds of the mesentery. A small depression, known as the hilus, is usually present at one portion of the node, marking the point of exit of the efferent lymphatics and the blood-vessels. The nodes lie in a soft connective tissue and are quite freely movable in the fat which often surrounds them. They are normally of a reddish-gray color, and a cross-section of a freshly removed node is usually somewhat translucent.

The nodes are surrounded by a thin, fibrous capsule containing some fat tissue and blood-vessels, and occasionally a few smooth muscle fibres. The capsule sends processes into the node which are known as trabeculæ. The capsule and the trabeculæ send off fine connective-tissue fibres into the substance of the node, forming a delicate network in the meshes of which lie the leucocytes forming the parenchyma of the organ. These cells are chiefly of the variety known as lymphocytes, which possess a single large spherical nucleus and a relatively small amount of cell body.

The masses of lymphocytes near the periphery of the node are collected into nodules known as the follicles or secondary lymph nodules. They are surrounded by a lymph sinus, derived from the division of the afferent lymphatics into an anastomosing network of spaces lined with flattened endothelium. In the centre of the follicles a lighter area can often be seen in stained sections, where the cells are slightly larger than in the periphery of the nodule and often show karyokinetic figures. The lymphocytes are formed in these germinal centres, as they are called, and pass from them to the periphery of the nodule, from which they are set free in the lymph stream of the sinus.

In the centre of the lymph nodes the arrangement of the lymphocytes is somewhat different. They do not lie in masses as in the cortical nodules, but are suspended in strands in the connective-tissue network lying between the trabeculæ, and are called medullary cords. Each cord is surrounded by a lymph sinus which separates it from the trabeculæ.

The lymph sinuses are formed from the afferent lymphatics, some of which enter the node at the sinus, others through the capsule. They pass to the periphery of the node and break up there into an anastomosing series of vessels which pass inward and surround the follicles and the medullary cords, and finally reunite to form the efferent lymphatics and pass out at the hilus. The lymph sinuses so formed are lined with flattened endothelium.

The blood-vessels enter chiefly at the hilus and are distributed first to the medullary cords and then to the secondary nodules.

Reticular tissue containing lymphocytes is not confined to the lymph nodes, but is found in the organs and especially in the mucous membrane of the digestive tract. The tonsils and crypts in the tongue, the solitary and agminate follicles of the intestine are examples of such collections. The structure of these deposits of lymphoid tissue varies from that of the lymph nodes. The development of lymph sinuses and germinal centres is much less complete than in the nodes. The lymphocytes are also not wholly carried off in the lymph circulation, but many of them wander out through the epithelial layer covering these collections of lymphoid tissue and enter the digestive tract.

The agents which incite pathological changes in lymph nodes are as a rule carried in the lymphatics to the node and first enter the lymph sinuses at the periphery of the node. Coarser particles of foreign matter, such as dust or soot, are often deposited in this portion of the node, and are taken up by the phagocytic endothelial cells of the sinus. The same is true of the cells of tumors which are found first in the periphery of the node where they occupy the sinuses. The effects of bacterial poisons are often most marked in the peripheral portions, though the bacteria are usually caught in the filters of the nodules or

medullary cords. Thus, tuberculous foci generally begin near the centre of the node and may leave the peripheral portions in a more or less normal state.

THE PATHOLOGICAL CHANGES IN LYMPH NODES.—*Pigmentation.* The pigment which is most frequently found in lymph nodes is derived from soot or coal dust. Silicious material inhaled by stone-cutters or grinders may also be transported to the bronchial lymph nodes. Deposits of iron oxide are found in the nodes of iron workers. The pigment may also be derived from the substances used in tattooing, which are chiefly India ink and vermilion. Finally, the pigment may arise in the body from the destruction of the red blood corpuscles, either following hemorrhage or produced by parasites, such as the plasmodium malariæ. The brown pigment which colors the skin and mucous membranes of those suffering from Addison's disease, may also be carried to the lymph nodes.

The pigment collects first in the lymph sinuses at the periphery of the node, being carried thither either by the lymph stream or by phagocytes. It may remain in this position either in the meshes of the fibrous reticulum or in the endothelial cells lying in the sinus. If the amount of pigment be very large, it is finally carried to all portions of the node and fills the nodules and the lymph cords.

A small mount of pigment may not cause any change in the structure of the node, but large quantities induce a chronic hyperplasia of the fibrous tissue which may result in a more or less complete destruction of the cells and the reticulum of the node, and their replacement by dense pigmented connective tissue. This chronic inflammation may involve the periglandular structures and give rise to dense connective-tissue masses about the node. Such nodes are of course functionless.

Atrophy. The lymph nodes of children are larger than those of adults, so that a slight atrophy of these structures takes place during life. In old age a more complete atrophy, with a diminution in the number of lymphocytes and thickening of the fibrous tissue of the node, is a regular occurrence. The node may be reduced to a mere shell, the centre of which is filled with fat tissue; or it may be small and hard and the fat tissue lie about it. Such nodes are paler than normal owing to the increase in the amount of connective tissue and to a diminution in the blood supply.

Amyloid degeneration of the reticulum and of the walls of the blood-vessels may appear in the lymph nodes as a part of a general amyloid degeneration of the organs of the body following prolonged suppuration, tuberculosis, or syphilis, or it may be limited to the nodes. In the

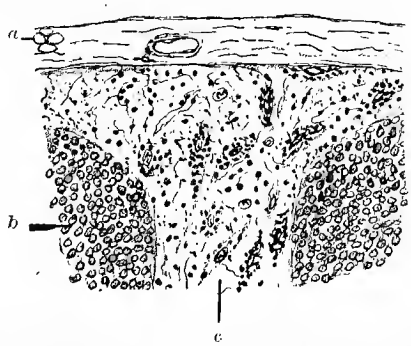


FIG. 3312.—Pigmentation of Lymph Node, with Chronic Inflammation. *a*, Capsule; *b*, follicle; *c*, dilated sinus with phagocytes carrying pigment. (Dr. F. C. Wood.)

latter case, amyloid degeneration is most frequently seen in the hyperplastic nodes of pseudoleukæmia, and in chronic or tuberculous inflammation. In advanced cases the fibres of the reticulum may become greatly swollen so as to cause the parenchyma of the node to undergo atrophy. Under such circumstances the node is hard and transparent and gives a mahogany brown when treated with tincture of iodine. Sections stained with methyl violet or thionin show the metachromatic staining characteristic of amyloid in the other portions of the body.

Hyaline degeneration of the walls of the vessels and the reticulum is occasionally seen in tuberculous or carcinomatous nodes or in old age.

Fatty degeneration is seen chiefly in the lymphocytes in connection with acute inflammation of the lymph nodes.

Fatty infiltration of the nodes is occasionally seen in obese persons, and may follow the atrophy resulting from chronic inflammation or old age.

Calcification of the nodes is seen chiefly in old tuberculous or suppurative lesions where the lime salts are deposited in the necrotic areas, but occasionally carcinomatous nodes will be found to be calcified, especially in slow-growing scirrhous carcinomata of the breast, when the axillary nodes have been invaded for a long time and degeneration has taken place in the tissue of the new growth.

Animal parasites have been found in the lymph nodes in rare cases. The embryos and adult worms of the filaria sanguinis hominis have been seen, and also the embryos of the trichina spiralis. Cysticercus and the echinococcus embryos have also been seen.

Acute Lymphadenitis. Acute inflammation of the lymph nodes is due to the presence either of micro-organisms or of their toxins. In these conditions the lymph nodes are enlarged and contain a considerable amount of serum. The capsule is distended and the blood-vessels are strongly injected. The color of the node under these conditions is a much darker red than normal. When the condition is advanced, the node softens and the softened tissue can easily be scraped from the cut surface. According to the microscopical changes which take place lymphadenitis may be divided into the hyperplastic and the exudative forms. In the hyperplastic form the changes are largely due to a proliferation of the cellular elements of the follicles, of the endothelial cells of the sinuses, and of the connective-tissue cells of the node. The endothelial cells, especially in typhoid fever, can often be found lying free in the sinuses or attached to the trabeculæ and very much swollen. The germ centres may be large and may show numerous mitoses in the early stages of the disease. Later, necrosis of the hyperplastic tissue is frequently seen and the cells cease to take any stain. In other cases the inflammation is distinctly suppurative, and in addition to the hyperplastic changes there are present lymphocytes and leucocytes from the circulation, together with hemorrhages from the blood-vessels. The tissues in the centre of the node soften, break down, and form, in this way, larger or smaller abscesses.

In very severe infections the inflammation takes on a hemorrhagic character, and the sinus may be filled with blood and a fibrin network which may finally extend between the necrosed cells of the follicles. The diphtheria bacillus is usually the inciting agent in the production of the hemorrhagic type of acute lymphadenitis, though the typhoid and anthrax bacilli may act in a similar manner. The bacillus of plague has a like action on the lymph nodes, and the nodes invaded by this organism are quite constantly the site of extensive hemorrhages, due to the necrosis of the walls of the blood-vessels produced by the toxin of this bacillus.

Very frequently the process does not remain confined to the node, but extends to the perinodular tissues, forming a periadenitis. When the process is confined to the nodes, healing may take place by resorption of the contents of the necrotic areas, and repair by the production of fibrous tissue; or, if these areas are of considerable extent, it may take place by absorption of the fluid and encapsulation of the dry mass by fibrous tissue. The débris remaining often undergoes a final process of calcification.

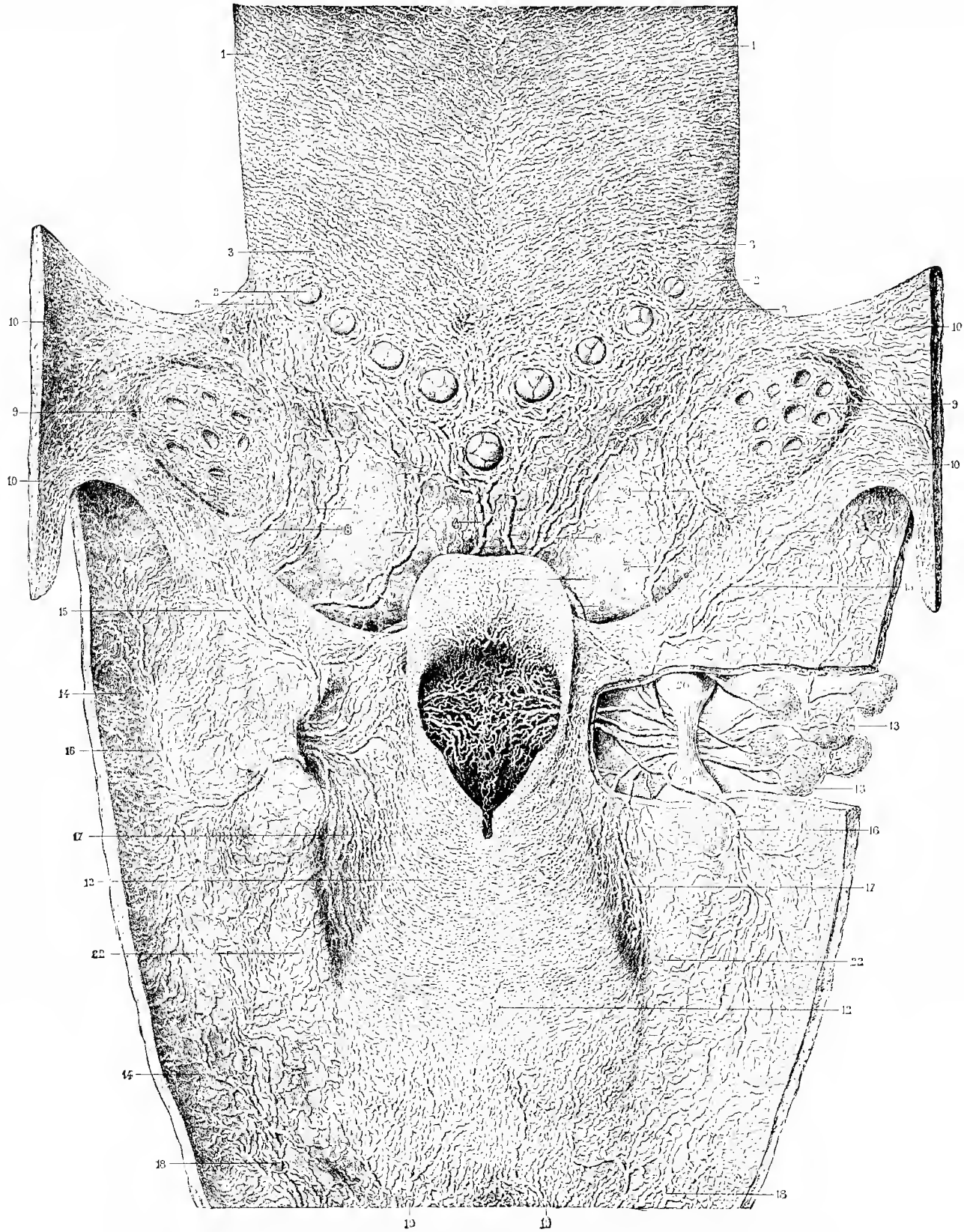
Chronic Lymphadenitis. This condition is characterized by chronic hyperplasia of the various elements of the node. It may be seen in conditions in which the

EXPLANATION OF
PLATE XLII.

EXPLANATION OF PLATE XLII.

Which Represents the Base of the Tongue, the Tonsils, the Pharynx, and the Opening of the Larynx of Man. The Pharynx was Divided on the Dorsal Side, and the Walls were Reflected. (Sappey, "Atlas.")

1, 1, Lymphatic network on the dorsum of the tongue, the general direction of the vessels is obliquely toward the raphe (meson) and the base of the tongue; 2, 2, circumvallate papillæ in the form of a V; 3, 3, 3, 3, vessels surrounding these papillæ and soon converging to form mesal and lateral trunks; 4, 4, lymphatic trunks extending along the meson from the middle circumvallate papilla; 5, 5, continuation of 4, one on each side of the middle glosso-glottic fold, and finally penetrating the lateral fold, they enter the lymphatic glands (13) of the ental cervical plexus near the lateral thyro-hyoid ligament; 6, 6, other trunks farther from the meson, taking the same course; 7, 7, lateral trunks from the base of the tongue, tonsil, etc.; they penetrate the pharyngeal mucosa and terminate in the same group of glands, but cross the dorsal instead of the ventral surface of the great cornu of the hyoid; 8, 8, trunks coming from the anterior pillars of the fauces, skirting the edge of the tonsils, and finally entering the cephalic, ental (superior deep) cervical lymphatic glands; 9, 9, the tonsils, covered by a dense network of lymphatics; 10, 10, 10, 10, the reflected sides of the arch of the palate (just below the "10" on each side is the divided uvula); 11, dense lymphatic network covering the epiglottis and extending upon the aryteno-epiglottic folds; 12, 12, a similar very dense and fine network of lymphatics upon the pharyngeal mucosa covering the larynx; 13, 13, several lymphatic glands belonging to the cephalic, ental (superior deep) cervical lymphatic glands, situated at the level of the thyro-hyoid ligament; as is evident from the plate, they receive the trunks from the base of the tongue, part of the palatine arch, the tonsils, the larynx, and a great part of the pharynx; 14, lymphatics arising from the ventral and lateral part of the pharynx; 15, 15, lymphatics from the posterior pillars of the fauces, they wind round the ventral edge of the great cornu of the hyoid and enter the deep cervical glands at 13, 13; 16, 16, lymphatics arising from the dorsal and lateral aspect of the pharynx and extending to the cervical glands at 13, 13; 17, 17, lymphatic trunks on each side of the larynx to the ental cervical glands at 13, 13; 18, 18, lymphatics from the dorsal and lateral wall of the pharynx next the œsophagus, they extend toward the thorax and enter the chain of ental cervical glands along the trachea and œsophagus; 19, 19, lymphatics from the ventral part of the pharynx, and extending to the chain of ental cervical glands in company with 18; 20, summit of the great cornu of the hyoid exposed by the removal of the pharyngeal wall; 21, end of the major horn of the thyroid, connected with the hyoid by the thyro-hyoid ligament; 22, 22, dorsal border of the thyroid cartilage showing through the pharyngeal wall.



BASE OF THE TONGUE, THE TONSILS, PHARYNX, AND OPENING OF THE LARYNX OF MAN

(SAPPEY, ATLAS)

EXPLANATION OF
PLATE XLIV.

EXPLANATION OF PLATE XLIV.

Which represents the arteries, veins, and lymphatics of the different layers of the stomach, and the lymphatics of the layers of the small intestine of the dog. (From Franklin P. Mall.)

FIG. 1.—"Reconstruction of a Small Portion of the Middle Zone of the Stomach. The long diameter of the drawing is in the direction of the longitudinal muscle fibres. It was built up from thirty-six drawings, and each drawing is an exact representation of a specimen." Enlarged about 10 times. (*a*) Mucosa; (*b*) muscularis mucosæ; (*c*) submucosa; (*d*) circular muscular layer; (*e*) longitudinal muscular layer. Arteries, red; veins, blue; lymphatics, brown.

As shown in the drawing the arteries and veins form a coarse network in about the middle of the thickness of the submucosa, and from this meshwork branches pass directly through the circular muscular layer on one side and through the muscularis mucosæ on the other. Between the muscular layers another meshwork of vessels is formed, but after passing through the muscularis mucosæ the arteries in the dog extend directly into the mucosa and break up into capillaries between and around the glands. In the cat a network of arteries is formed after traversing the muscularis mucosæ, and from this network twigs pass into the mucosa and break up into capillaries.

The veins form a meshwork near the free surface of the mucosa. From this first meshwork branches pass down to the muscularis mucosæ and there form a somewhat coarser network at the base of the gastric glands. From this mucosal network the vessels penetrate the muscularis mucosæ and accompany the arteries.

The lymphatics begin by blind, branched, finger-like vessels between the gastric glands. These finger-like beginnings unite and form a meshwork between mucosa and muscularis mucosæ.

Another meshwork is formed on the opposite side of the muscularis mucosæ and from that point a coarse network is formed in the submucosa and between the muscular layers. Valves appear in the lymphatics as they penetrate the muscularis mucosæ. The vessels penetrate the walls of the stomach and pass to lymphatic glands along the greater or lesser curvature as shown in Plate XLIII.

FIG. 2.—Segment of the Small Intestine of a Dog to Show the General Distribution of the Lymphatic Vessels. Mucosa and villi, white; muscularis mucosæ, blue-green; submucosa, pink; circular muscular layer, orange; longitudinal muscular layer, yellow; lymphatic vessels, blue. (*Fl*) Lymph follicles in the mucosa (cf. Fig. 3); (*M.L.*) mucosal lymphatic network; (*S.M.L.*) submucosal lymphatic network; (*I–Msl–L*) intermuscular lymphatic network. The efferent lymph vessels from the submucosal and intermuscular networks are shown below at the mesenteric edge of the intestine. From this point they pass to the lymphatic glands (cf. Figs. 3272, 3281–3286).

Some of the villi are represented with the club-shaped central lacteal or lymphatic. It will be noticed also that at the base of the villi there is a lymphatic network, and that in passing from one layer to another of the intestines the vessels pursue a nearly straight course (cf. Fig. 3). The passage through the muscularis mucosæ is indicated by blue dots, thus giving it a sieve or punctate appearance.

FIG. 3.—Section of the Small Intestine of a Dog to Show the Arrangement of the Lymphatics in the Villi and in the Different Layers. Lymphatics, blue; villi, two crypts of Lieberkühn, muscularis mucosæ, a lymph follicle and the longitudinal muscular layer, pink; mucosa and circular muscular layer, white; submucosa and one lymph follicle, gray. One of the villi is shown in an uncontracted condition. The others were strongly retracted by the use of ten-per-cent. nitric acid.

In this figure is well shown the club-shaped central lacteal or lymphatic with a slender, spiral projection extending nearly to the end of the villus (cf. Fig. 3294). In the second villus from the left two central lacteals are shown.

From the network at the base of the villi the vessels extend directly to the mucosal network (Fig. 2, *M.L.*). From this point on they possess valves. Surrounding the lymph follicles is a dense lymph network. The figure shows also that the muscularis mucosæ is not present over the lymph follicles

FIG. 1

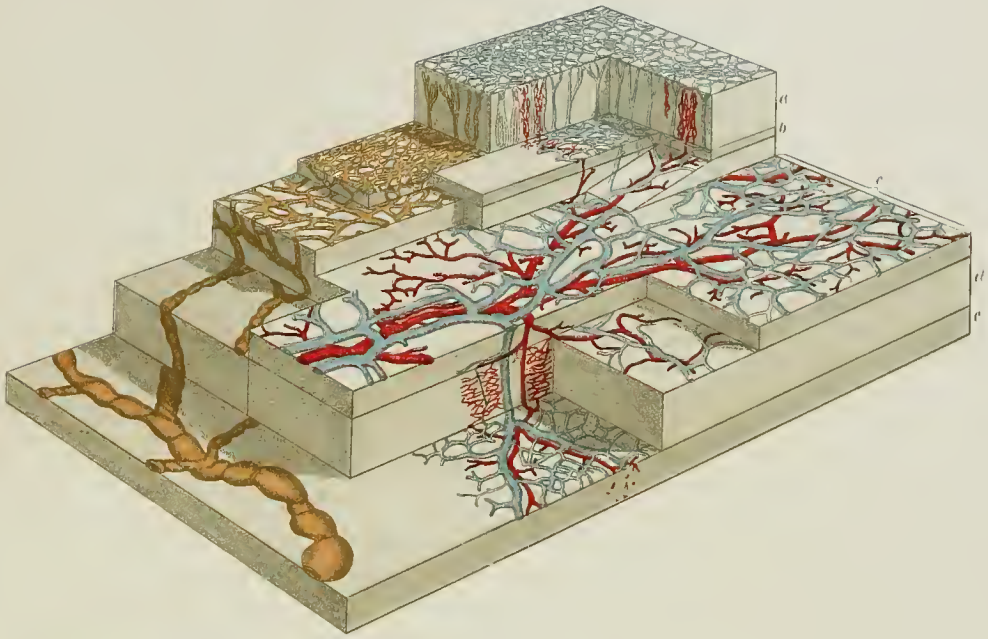


FIG. 2

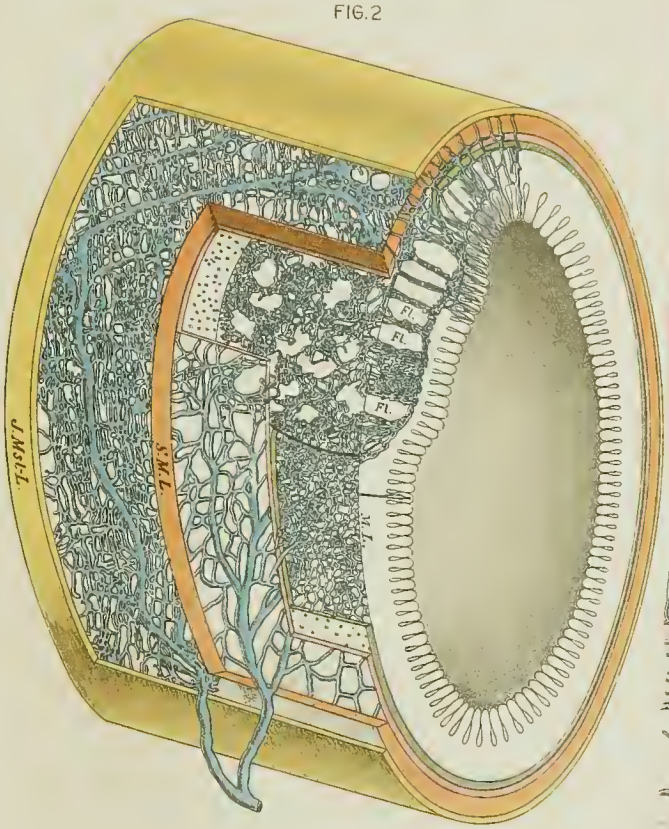


FIG. 3

Blood Vessels and Lymphatics of the Dog's Stomach
and Lymphatics of the Dog's small Intestine.
(FROM FRANKLIN P. MALL.)